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Engineering News-Record

Eleven-Pipe Penstock Line at Rjukanfos Plant in Norway

Notes on European Practice in Penstock Design
By Oren Reed

Gravity Pipe Lines for Gathering Crude Oil
By L. E. Davis

Layout of Concreting Plants for Three Warehouses
By L. C. Hammond

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Editor

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Spectacular Reporting

ATTENTION is called to Mr. McWhorter's admirable report of the enforced breaching of the levee below New Orleans which appears in news columns of this issue. The difference between a plain statement of fact by an engineer and the newspaper reporter's "story" will be evident to every one who has been trying for a week to find out what really happened at the Caernarvon crevasse. Evidently the gentlemen of the New Orleans press expected to see some such spectacular explosion as the famous Petersburg mine followed by a Johnstown flood, and when the river started into the lowlands through the three ordained trickles their disappointment was so great that they branded the whole enterprise a failure. Doubtless the engineers were too busy to take the press into their confidence, nor does the false reporting make much difference now. It merely emphasizes the difficulty, often reverted to here, of getting authentic information on technical matters through the regular news reporting agencies.

Open to Question

IN THESE days of high-pressure competition between different classes of material, when a public agency rescinds its earlier approval of plans made by its engineers and, against their strong protest, adopts a competitive material, it lays itself open to question. This is what has happened in the case of the North Jersey District Water Supply Commission, which voted last week to use for the Wanaque aqueduct a steel pressure pipe instead of the concrete conduit on the grade line and either steel or reinforced concrete for the pressure line as approved by the same commission in 1924. The commission some two years after adopting concrete engaged a special consulting engineer to report on the subject and is following his advice, but the commission's chief engineer and permanent consulting engineer are so radically at odds with the special consulting engineer on capacities and costs as to warrant at least a Scottish verdict in the case. The main points of difference are stated in the news columns of this issue. It is impossible now to go into technical details because the commission refuses to give this journal copies of the reports and counter reports of the engineers before the question as to size—one of the crucial questions—is settled. Such refusals by public bodies indicate fear of public and technical criticism of proposed action.

Exceptional Frost Protection

FORM insulation and admixture as supplementary protection in winter building construction by progressive canvas housing are given complimentary reference in the suggestive article in this issue on concreting-plant planning for three large warehouses. The praise need not be repeated here. The thing that calls for emphasis is that these precautions against frost were used with no diminution of curtaining and heating. These conformed in all essential particulars to usual practice. Insulation and calcium chloride were supplementary devices. It is important to observe, however, in what places they were used and why in those places. In regular progressive canvas housing practice, i.e., outside curtains inclosing the story below the floor slab and floor slab canvas covers on trestles, there are two places of especial frost danger. One is the outside of wall columns and girders, and the outside curtain walls. Every experienced winter builder knows that his greatest wall and column frost hazard is here, and is meticulous in his attention to curtailing and heating these parts. On the Montreal warehouse it will be observed, it was the wall forms that were insulated. Another, the second, point of danger is the floor slab during the period of its pouring and finishing in the open before trestle and cover can be placed and the heat admitted from the story below. It was to delay frost action while pouring and finishing the floor slab that calcium chloride was employed. The contractors report that it gave them a leeway of about an hour. In general, insulation is a rather clumsy device where forms have frequently to be shifted and reused and admixtures at best only lengthen a little the period before enclosure and heating are essential, and neither has been much employed in the thin slab and slender framing work of buildings. The instance described is a noteworthy variation of practice.

Continuing Education

IT IS one of the functions of an engineering journal in which an editor takes most pride that it extends education, and so in a modest way ranks with the technical college and the university. For this reason we take special pleasure in noting evidences of a movement toward making education available to engineers during their long post-graduate life. Evening courses in several subjects were given by the New York Chapter of the American Association of Engineers during the past month, and its closing or certification celebration, held two weeks ago, brought to light an enthusiastic appreciation of the merits of this effort, and thereby of the vitality of the idea which it embodies. There is much more to be done in this field—a vast amount, indeed. Collegiate engineering education is bound to remain confined to the underlying sciences, while of the extensive areas in the applied science, as well as in other fields of knowledge more or less distant from engineering, the engineer must obtain his knowledge after college, through his own efforts, guided as well as may be by the exigencies of his daily work and life. This continuing education is apt to be confined to a narrow zone, that range of operations in which his regular activity happens to lie. Of economics, of business, of history, of the humanities in general, the engineer may largely escape all knowledge. The

tremendously growing domain of social facts and relations, without knowledge of which the modern man can hardly be a truly constructive member of society, lies quite to one side of his work. In time, we may hope, educational institutions generally will come to recognize that they have an educational function beyond the limits of the fixed college course. In the meantime, societies and associations of technical men can find no more constructive activity than this one of providing their members with opportunity for extending their education, by direct instruction or by guided self-study, or both. We strongly hope, then, that such work as that noted may continue and spread.

Keep Car License Taxes

AUTOMOBILE organizations and inspired legislators who have this year combated further gasoline taxation and insisted that if it were imposed common justice demanded a reduction in license fees will be interested in the article in this issue by Professor Martin of Emory University. The Georgia economist, who by the way has recognition as an expert on taxation, argues forcefully that sound and just as is the gasoline tax as representing road use, it does not alone represent all the service demanded of roads by all vehicles. For example, very heavy trucks and those with solid tires make destructive use of roads way beyond any sum measured by their greater gasoline consumption. It is as a measure of this extra use that a license fee needs to be imposed in addition to whatever gasoline tax may be considered wise. The reasoning may be read in the article elsewhere. It deserves to be read because the argument for license fee reduction if gasoline taxes are to be imposed has been one of the soundest to be offered by the motor vehicle organizations.

High-Head Penstocks

EUROPEAN engineers have long since developed the more easily accessible hydro-electric power sites and have gone to higher and higher heads to supply their power markets from local sources. In this country, too, we are tending toward higher heads; in California last year there were simultaneously under construction three hydro-electric developments in each of which the static head exceeded 2,300 ft. and any one of which exceeds the previous high-head record for this country. One of these has been completed and is now in operation. Some of the penstocks for these plants were fabricated in Europe. European practice in the manufacture and testing of such penstocks concerns American engineers whether the pipe for future American high-head plants is built here or in Europe. If we build it here we should profit by the years of experience with construction of this type in foreign plants; if we continue to buy from European makers, familiarity with their methods is desirable in order that specifications may be written to good advantage and so that delays in communication may not seriously complicate exigencies that arise during erection. The observations of Mr. Reed published in two articles, the first of which appears in this issue, give first-hand impressions of European practice with banded pipe. He frankly confirms the indeterminate nature of the stresses in such pipe, which is one of the chief objections raised by American engineers who have opposed its use. On the other hand, the destruction test of full-size pipe which he cites in the second article supports the contention that when rupture does occur in banded pipe it is so localized that damage due to escaping water is in nowise comparable to that resulting from the rupture of high-head penstocks such as have occurred on the Pacific Coast in recent years. There is some question as to whether the initial internal stresses set up by shrinkage of the bands put on successively, can be so controlled that the resultant stress in the core of the finished pipe section is uniformly distributed. However, regardless of just what this condition may be, the illustrations showing the deformation of the banded pipe tested to destruction which are to be given in the second article are convincing evidence of the strength of well constructed pipe of this type.

Canals Aid Rapid Transit

CANALS have their use as trafficways even though the day of the canal boat is fast disappearing. The old beds of the Erie canal at Rochester, N. Y., and of the Miami canal in Cincinnati have both been utilized for the right-of-way of rapid transit urban lines and for the entry of interurban lines to the city. Now Newark, N. J., has the opportunity to do the same thing, for the city has just taken possession of the bed of the old Morris and Essex canal which extends north from the city around the Orange Mountains up into New Jersey. The city has purchased only the 6 miles of this abandoned waterway within its limits, but that length is admirably suited for the roadbed for some of the street cars which now crowd the congested streets of downtown Newark. While the arrangement with the local street railway company has not yet been made, the opportunity to improve urban transportation through the old canal bed is so great that it is impossible that some agreement will not be made whereby the many advantages of rapid transit can be obtained at a low cost. A similar improvement of a somewhat different kind is to be studied in Toledo, Ohio, where the old bed of the Toledo and Maumee canal is to be surveyed for its possible use as a motor boulevard. Other times, other manners.

The Problem of the Mississippi

IN THE intervals between Mississippi floods only those charged with responsibility for the river think very much about it. As soon as the water overflows the land once more the century old problem takes on new life and every one, amateur and expert alike, rushes into the argumentative fray. The methods used on the Mississippi have not been completely successful, else there would be no inundation. But the river is in flood, high water marks are being exceeded and large areas are being submerged down the whole valley. The average citizen—long trained to expect the impossible from the engineer—wonders why this thing is allowed to go on and passes by easy stages to acceptance of all or most of the advertised solutions which are offered.

Congressmen wire the President that the flood "is a part of the tragic price we will all pay for our folly of forest devastation" and the Secretary of the Treasury and Senator Curtis, according to press reports, agree that "the best approach would be by construction of storage reservoirs on the headwaters of the Mississippi to impound surplus waters during flood periods and distribute it for power production or irrigation." Contour plowing, outlets, spillways, parallel channels—all the old

familiar alternatives and correctives to the levee system—are brought forth just as they have been again and again for the last fifty years.

But because this is the most destructive flood we have ever known and because the nation has been at last aroused, it would seem, to the seriousness of the problem before it, there is more than a fair chance that at last we are to have a real national effort to alleviate the flood menace of the Mississippi valley and to devote to the problem the national study and the national funds that it has long deserved. Those delegated to the task of planning that effort will in due time analyze the problem and give the proper weight to the schemes proposed, but meanwhile it would be well that the popular mind get some sense of proportion in the problem.

There is, for instance, no proof that deforestation has increased floods, and even if there were such proof, nothing can be done about it so far as the Mississippi is concerned. Certainly, no restoration of forests can effectively be made in this great valley with all of the appendages of modern civilization that have grown up there. Similarly, there are basic fallacies in the conception of headwater pools to catch the rain as it falls and to hold it to be led down to the main river if and as desired, meanwhile gaining power thereby from the effective head through the generation of electric energy. You cannot hold water and use it too, nor can there be found space in the head valleys of the tributaries where adequate reservoirs can be built for any sum within reason. And if such money could be provided man has not sufficient prescience always to dispatch the waters from this multitude of reservoirs, from the Rockies to the Appalachians, from Santa Fe to Pittsburgh, so that they will reach the Mississippi at intervals that will not conflict to cause flood. Headwater reservoirs can have some local beneficial effect; they cannot prevent the synchronous combination which causes such a flood as is now going down the river, even were they economically feasible.

The ultimate levee program for the control of the floods of the Mississippi contemplates parallel levees extending from above the Ohio to the delta and up the tributary streams, all at an elevation sufficient to retain the river at any flood that comes. Money has not been made available, however, either by local communities, state or federal government, and the levees still fall far short in extent of those necessary to a complete scheme and only for a part of their extent do they reach the present designed final height. The time when such a system would be completed is far off. Every new levee that is built, every foot that is put on top of an old levee, makes necessary higher and stronger levees below. The question inevitably arises: "How far can we continue the process"?

Can the levees be made high enough and strong enough to resist the inevitable higher water which the combination of events in the future will bring or is it time now to consider the possibility of relief flooding? The Mississippi is a series of basins, basins which in spite of the protection of the levees have been filled either in whole or in part by the great floods through breaking of levees, by backing of the waters up the tributaries and by the rain falling on their own drainage areas. Would it be better to conceive of these basins as temporary lands, merely retrieved for a time from the waters, and to be used always with the possibility of enforced flooding in view?

There are economic objections to the parallel basin or channel but it will be well now to go into them more thoroughly than ever before and to balance them against the losses that the country is experiencing from the present flood. Devotion of the entire basin to the occasional flood flow means abandoning the idea of permanent development of large productive areas. Parallel channels mean secondary levees to hold the far edges of the basins formed, and they may cost more than a major system of levees, but they will be lower than the main levees. The main levees, too, whether there be secondary levees or whether complete flooding of the basin is contemplated, need not be carried so high when relief is provided. And height of levees is a very important factor in their strength. Indeed, the vulnerability of the earth levee combined with the fact that a single break is almost as serious as a complete washout of miles make necessary again a review of the structural possibilities of this thousand-mile dam. Here again the economic balance between the cost of assured protection and the occasional loss of flooded land must be drawn.

It may be, too, that the time has come when permanent spillways, comparable to the emergency one blown out last Friday, shall be provided. A spillway is applicable only to the lower river, for its essential feature is that the water that passes through it does not return to the river but passes by other channels to the gulf. There are hydrologic objections to its use. They are a part of the complicated behavior of great river systems, a subject on which knowledge is still mostly empirical and none too well authenticated. The control of the Mississippi is not alone a control against floods, it is also a control for navigation and for stability. That which might insure against floods might destroy a low water channel, and it is that possibility which has led to the opposition to the spillway, and to a degree, to outlets or parallel channels. In the present serious emergency, channel control and navigation had to go by the board and for the first time in history an official breaching of the levee system has been made. The fact that such an emergency arose and was so met is significant indication that flood control demands are becoming so imperative that the channel control theory of opposition to spillways is under fire. The enforced break at Caernarvon is not only a flood relief measure but a great experiment in river hydraulics.

These are some of the questions that will come up in the consideration of the Mississippi in the next six months. The problem needs a complete re-examination, for the nation is in the mood to offer as real relief as human ingenuity can devise. Meanwhile let us hope we will be spared the reiteration of the headwater reservoir fallacy, especially in the impossible, though popular, combination of storage and development for power. Let us hope that there will be as little as possible of the fanatic outbursts about forests. What has to be considered is the eventual costs of complete leveeing by structurally adequate levees together with the losses due to breaks, and to count against that the establishment of occasional flooded areas occupied in the dry seasons merely as temporary homes and farms. The floods are recurring too frequently. The areas affected grow larger and more prosperous. The cost in life and money is very great. The nation must recognize its obligation and begin to devote real thought and much money to the relief of the Mississippi valley.

Notes on European Practice in Penstock Design

Methods and Details in Design and Construction of High-head Penstocks, Notably in Italy, Switzerland and Norway—First of Two Articles on European Penstock Practice

By Oren Reed

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EUROPEAN engineers have had extensive experience in building hydro-electric plants to operate at very high heads, and details of design and construction developed there, particularly in penstock practice, have become of increasing interest to American engineers as more and more high-head projects are built in this country. In the course of two European trips in 1923 and 1926, totaling some 21 months, the writer visited fourteen major hydro-electric plants in Italy, Norway and Switzerland, to study and compare hydro-electric practice there with that in vogue in America. Chief features of the observations and conclusions made on those trips are reviewed in the following.

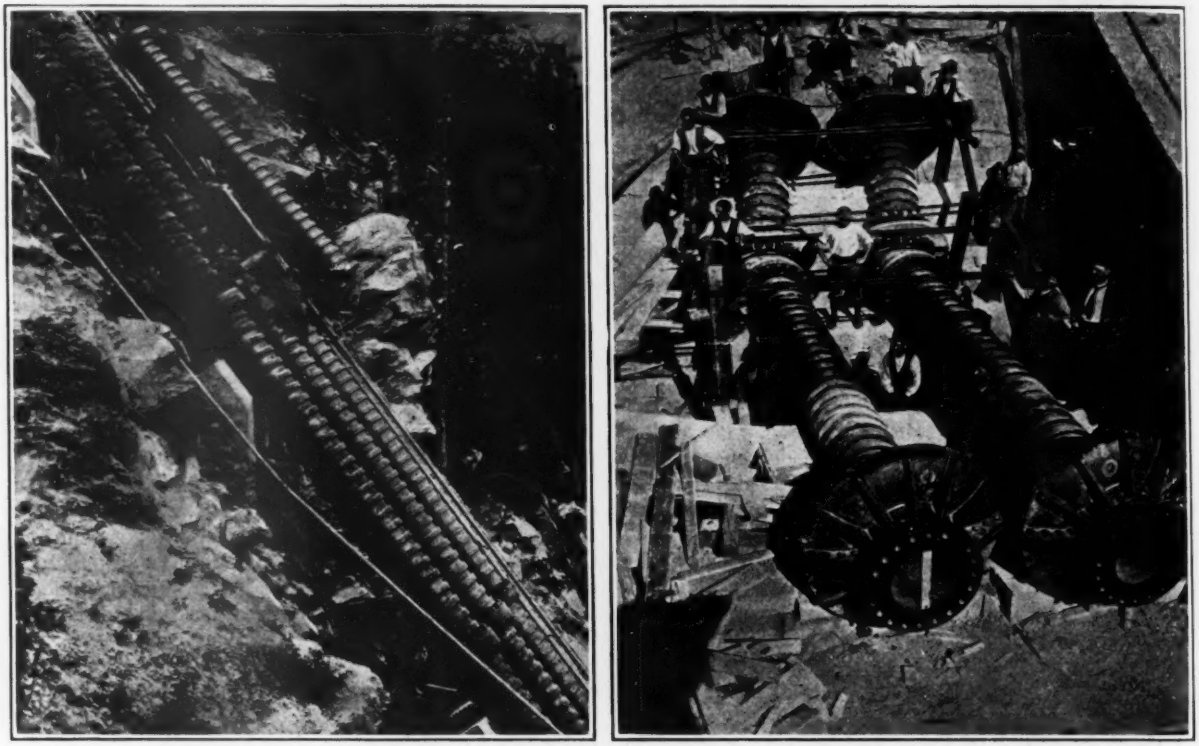


FIG. 1—PENSTOCK ERECTION AT MONCENISIO, ITALY
The static head is 3,600 ft. At right—Bends and pipe sections ready for concreting anchor.

The three countries named have proceeded rapidly in recent years with the development of their water-power resources due to economic conditions, and high-head plants are numerous in the mountainous regions. The highest head developed in Norway is one of 2,875 ft. at Bjolve. In Italy and Switzerland, respectively, the record-head plants are at Moncenisio, 3,600 ft., and Lake Fully, 5,400 ft. The largest development is at Rjukanfos in Norway where 239,000 hp. is developed in two plants with heads of 982 and 897 ft., respectively.

Intake—In contrast to the usual case with high-head plants in America, where the water is taken from a reservoir confined by a high dam and led to the forebay in a pressure tunnel, in Europe the supply tunnel is often of the non-pressure or flow type. In many cases, as at Rjukanfos and Tysse in Norway, natural lakes are regulated by low dams. Water released from such storage is conducted to open forebays by unlined flow tunnels having a slope of 2 to 2.15 per 1,000. At Rjukanfos, where the flow is 1,920 sec.-ft., the forebay has an area of 10,770 sq.ft. and was blasted from the solid rock. It is roofed over with a light frame structure covered with corrugated iron. In other cases, as at Amsteg, Switzerland, and Moncenisio, Italy, the tunnel is under pressure and terminates in a surge chamber or compensating reservoir. At Amsteg the tunnel is under a pressure varying from 58 to 98 ft. of head and has a slope of 1.5 per cent. Tunnels are driven with a sufficient sectional area to give a velocity of 4.45 to 10.9 ft. per second (Saaheim, 5.45 ft. per second; Amsteg, 10.9 ft.; Moncenisio, 9.05 ft.; Vemork, 6.82 ft.).

Penstocks from an open forebay usually have a slide gate at the head of the pipe line with an automatic butterfly valve a short distance below. The use of a throttle valve at or near the head of the penstock has

become common practice in European high-head plants to shut off the flow automatically in case of a rupture of the penstock or of a serious disturbance in the water pressure. This valve may be a flap valve for medium heads, a butterfly valve or a needle valve for higher heads. At Rjukanfos the butterfly emergency valves are located in a masonry house about 150 ft. below the forebay. If for any reason the water acquires a velocity much above normal, the water pressure acting upon a

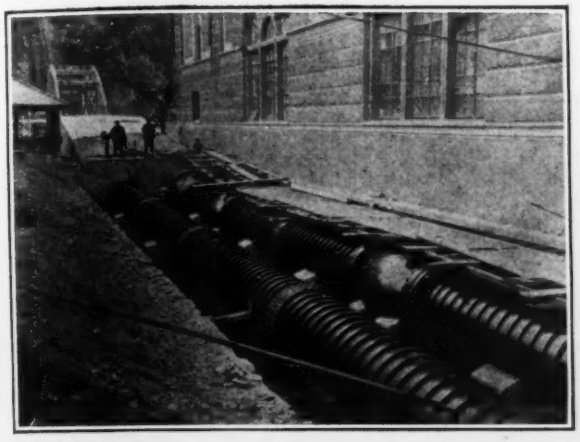


FIG. 2—PENSTOCK LINE AT COVALOU, ITALY
Distribution pieces and turbine connections of penstock. The static head at this plant is 1,825 ft. Bridge in background is two-hinged concrete arch river crossing carrying penstock line to power house.

lever or scoop, which extends down into the pipe, moves it enough to open the valve to the oil-pressure system.

Operation is manual, automatic, or by electrical circuit from the power house. The power house circuit actuates a small motor which opens a valve allowing oil at a pressure of 250 to 265 lb. per sq.in. to move a piston, opening or closing the throttle valve. The allowable increase in velocity at the valve is about 6.5 ft. per second. These valves have proved to be very reliable. Air valves are provided just below the intake gates and emergency valves to prevent collapse of the pipe if there should be a rupture in the lower section. In the pipe line at Lake Fully, automatic high-pressure needle valves are installed. These close at a predetermined variable speed as soon as a serious disturbance of the water pressure in the penstock occurs. The time of closing varies from 30 to 60 sec. to prevent serious water hammer.

At the forebay one or more sets of trash racks are provided. The space between rack bars is generally not more than 0.8 in. Sometimes a second rack is installed just in front of the inlet to collect ice, etc. The clear openings of this rack are about 1.6 in. in width.

Penstocks—Except in special cases, an uncovered penstock is favored in Europe on account of ease of construction and accessibility for inspection and repair. At Lake Fully, however, the pipe line was buried about 4 ft. underground, mainly on account of climatic conditions. Lake Fully, the source of the water supply, is 7,000 ft. above sea level. The Sieben penstocks, Waeggital project, are buried to relieve the anchors of expansion stresses, for good anchor foundations were difficult to reach. In order to eliminate the danger of snow and rock slides to the conduit system at Rjukanfos II, the penstocks are carried from the forebay to the power house in three tunnels, three pipes in each tunnel. At Herlandsfossen in Norway, the water is led from the surge chamber through 656 ft. of unlined pressure tunnel to the level of the power house, giving a maximum head of about 457 ft. on the tunnel. This tunnel subsequently gives place to two pipes, laid in an almost horizontal tunnel and 595 ft. in length, running to the power house itself.

Exposed pipe is supported on piers, one to each length of pipe. Piers usually have a bearing on the pipe of 120 deg. A smaller bearing is strongly opposed, especially for steep slopes, because of the possibility of the pipe being dislodged from its support due to expansion stresses. The piers are placed 3 to 4 ft. below the upper end of the pipe section. Usually vertical angles are necessary in the penstock profile and piers are relatively short, but at Amsteg, Switzerland, high piers were used to obtain a nearly unbroken profile. Anchors are placed at all angle points in the penstock line. These are made very massive and so designed that they will properly take care of all resultant forces on the bend by gravity alone. Dowels are used to obtain additional anchorage.

Ordinarily there is one expansion joint and one man-

FIG. 3—AMSTEG PLANT IN SWITZERLAND

hole in each section of the penstock between anchors. It has been found that there was but little expansion, when the pipes are flowing full, irrespective of the time of year, even in Norway where the seasonal and daily variations of temperature are very great. At Lake Fully, where the penstock is buried, no expansion joints are provided. Careful attention must be given that no unusual stresses are produced in the pipe line during erection, especially when the line is to be covered and

no expansion joints are provided. Erection is carried out when the temperature is approximately the average operating temperature.

If the penstock is to be covered, each section is backfilled after it is riveted up. This can be done only when the pipe has been carefully tested in the shop. Usually the joints are left open until the penstock has been filled and tested. As a further protection against temperature changes the line is progressively filled with water as soon as the concrete in the anchors is sufficiently cured. Joints are inspected after the filling is completed and then are backfilled. It has been found by experience that a penstock line having flange joints should be emptied after the initial filling because many of the bolts can then be tightened.

Each pipe section is painted inside and out with one or more coats of a coal-tar paint. At least one coating is applied while the pipe is hot. The inner coat of paint lessens the friction loss. Those sections which are to be embedded in concrete, as in an anchor, are sometimes given an outside coat of neat cement instead of paint.

The pipe is usually made in 20-ft. lengths, but in the upper reaches of the penstock where the plate thickness is small and where transportation facilities will permit, 30-ft. lengths are sometimes used. Pipe diameters are such that the velocity at the top is about 5.25 ft. per second and at the bottom it may be as high as 24.6 ft. per second, as at Moncenisio, but 16 ft. per second is ordinarily the maximum velocity. To lessen rusting and incrusting it is recommended that a least velocity of 2.6 ft. per second be maintained for steel pipe. High velocities and the resultant high loss of head are permissible where the plant operates at full load only a small per cent of the time. At Lake Fully the plant operates intermittently; when operating at full load the total loss is 530 ft. or nearly one-tenth of the static head.

In order not to exceed reasonable plate thicknesses in the lower sections of the pipe, it was necessary to use higher maximum velocities until the introduction of reinforced pipe. The latter consists of a plain lap-welded core pipe over which seamless reinforcing rings are shrunk at the required intervals. A common European standard is to use plain lap-welded pipe up to a plate thickness of 1¼ in. and for greater heads to specify reinforced pipe. In welded pipe, the common type of "bump joint" is used until the plate thickness exceeds ⅝ in. This joint is double-riveted except near the top. Below the bump joint a riveted band joint is used until the static water pressure reaches 1,130 lb. per sq.in., equal to a static head of 2,600 ft. This joint is very satisfactory but must be carefully made. The conical faces of the pipe ends and bands must make a close fit. A screw flange joint with rubber packing is used at the lower end where the pressure is too great for a band joint.

Some trouble has been experienced with the packing where it had to be renewed from the inside, requiring several adjustments to obtain a watertight joint. At Lake Fully forged steel pipe was used with a special joint, fastened together with flange rings and nickel steel bolts. Two wedge-shaped rings, 2½ in. to 1⅞ in. in thickness, are inserted between the pipe ends. By rotating these rings in a suitable manner relative to each other and to the end of the pipe, any angle up to 10 deg. could be made in any direction. Rubber seal packing, ¾ in. wide, is used between each steel ring.

FIG. 4—RJUKANFOS PLANT I IN NORWAY
Ten penstocks operating under a static head of 982 ft.

The following working stresses are used:

Location	Penstock — Plain, Lb. per Sq.In.	Penstock — Banded, Lb. per Sq.In.	Cast Steel Lb. per Sq.In.	Remarks
Breda Co., Italy	12,100	13,500	9,250	Design based on head+ 20 per cent; for distribution lines add 2 mm.
Ponale, Italy	10,650	12,800	8,550	Design based on static head; for distribution lines add 2 mm.
Norway	10,250 / 11,400	13,500	8,550	Design based on head+ 2 mm.
Austria	12,800	14,850	9,250	Design based on head+ 15 per cent; +2 mm.
Lake Fully	13,000	.....	.....	Forged steel; calculated on static head.

Special Sections—Distribution pipe consists of the special piping at the power house. In riveted pipe a stress of about 8,000 lb. per sq.in. is allowed. Each section of the pipe is tested in the shop to 150 per cent of normal working pressure. In most cases the penstock is tested again in the field by a 50 per cent overload.

Often two or more units are supplied from a single pressure line. The Dale (Norway) penstock supplies three impulse turbines by means of a cast distribution piece. The branches lead off from the main with angles up to 90 deg. At Covalou, in Italy, three turbines are supplied from two penstocks. All three turbines are supplied through 90-deg. branches from one penstock and this line is connected to the second pipe line by a U-shaped casting beyond the last turbine connection.

Water Measuring—Most modern plants are provided with Venturi meters and registering apparatus in the power house. Their location depends upon many factors such as pipe diameter, static presure, and maximum and minimum velocities. Doubt as to the accuracy of totalizing apparatus has led to the practice of planimetering the diagrams to obtain the total amount of flow in a definite period. At Partenstein, Austria, the Venturi meter is at the top of the penstock, where the diameter is 94.5 in. and working head 154 ft. The meter is built in a forged steel section of the penstock. The inlet collector ring and the throat are of cast iron while the taper sections are of concrete, lined with a thin steel plate. Although the minimum discharge is only one-tenth the maximum, the variation in accuracy is not more than 2 per cent. The flow record is made at the power house, 1,050 ft. distant, by an electrical integrating device.

In all large installations one or more workmen live near the forebay. These attendants run the cableway and take care of the forebay, forebay gates, and throttle valves. Cableways are used beside or above penstocks.

[*An article on European methods in fabricating and testing penstocks will be published in an early issue.* —EDITOR.]

Welland Canal to Be Completed by 1930

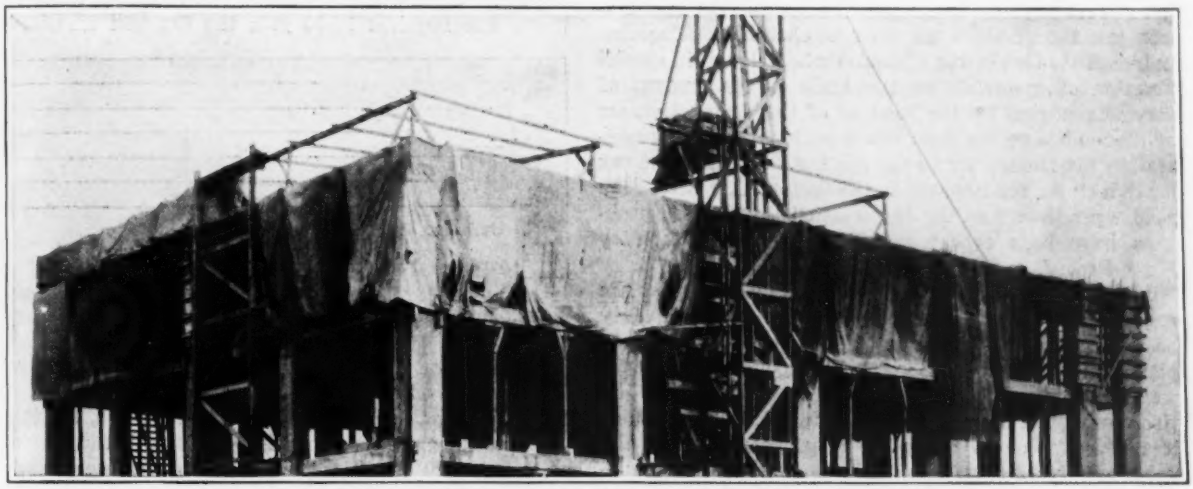
Subject to weather conditions and the continuance of government appropriations, it is expected that the Welland canal will be completed and ready for heavy-draft and big ship navigation by 1930, as stated by A. Grant, chief engineer. Port Weller, the Lake Ontario entrance, is now available as a port of refuge for steamers with a draft up to 25 ft. Sections 1 and 2 lying below the Niagara escarpment will be fully completed during 1926.

Effective Concrete Floor Protection for Winter Building

By Frank C. Boes
Tucker Construction Co., Inc., New York City

A FLOOR enclosure and heating system which made practicable the monolithic placing of finish and body in the floor construction in winter for a New York concrete building are illustrated here. As shown, the story below the slab being poured is completely enclosed with canvas, within which enclosure are placed salamanders. Holes about 6x36 in. are left in the floor over the salamanders, to permit the heat to pass up into the tentlike structure above, within which the floor finishing is being done.

The salamanders are started several hours before concreting is begun to get the forms warmed up. The holes are left covered until after the concrete is poured, to confine the heat. After the concrete has been poured, a rough framework of posts and beams is erected over the soft concrete, and completely covered with canvas; the holes are then opened up to admit the heat into the canvas structure, and the cement masons begin the finishing completely protected from cold, wind, snow or rain. Naturally, in such a housing, the cement sets up quickly. After the concrete has set sufficiently, the floor is covered with sawdust, the canvas cover is removed, and forms are erected for the next floor.



COLD WEATHER HOUSING FOR CONCRETE FLOOR CONSTRUCTION

The mixing water was heated by a low-pressure steam boiler, and a kerosene torch is attached to the mixer to heat the materials while they are in the drum. It was found that for a mixing period of 55 sec. the kerosene torch attached to the drum increased the temperatureture of the mix about 10 deg. For a longer mixing time, the temperature from this source would be increased accordingly. By heating the mixing water with steam, 15 deg. to 18 deg. more could be added.

Such an arrangement is economical and efficient and also elastic, as any factor, steam, kerosene torch, salamanders or canvas cover can be omitted on any pouring, if favorable conditions render it unnecessary.

The general contractors on this job are Tucker Construction Co., Inc., and the architects are Gretsch & Creamer, of New York City.

License Fee Properly Supplements Gasoline Tax

Full Service of Highways Not Paid For Without Registration Fee Impost on Weight and Tire Equipment

By James W. Martin
Department of Economics, Emory University, Atlanta, Ga.

THE FACTS indicate clearly (1) that the proportion of the cost of road building borne by the motorists is increasing, Fig. 1, and (2) that the percentage, of that part borne by the motorists, which is raised by means of gasoline taxation, is increasing more rapidly than the increase in the revenues raised by means of registration and other special taxes on the road users, Fig. 2. In view of these developments, it becomes important to analyze the success with which each of these taxes measures the service of the roads.

It has been pointed out many times that, if a choice is to be made between the gasoline tax and the registration tax, the gasoline tax must be chosen. Perhaps no unbiased student of the situation who believes in special taxation of motorists on the basis of the amount of service rendered by the road or of the destructiveness of the vehicle on the road would contend that the registration tax is superior to the gas tax. The gasoline tax bears a closer relationship to the factors that determine road wear than does the registration tax. These problems have been repeatedly discussed in *Engineering News-Record*.

If all this is granted, shall we conclude then that the registration tax can be dispensed with or that it may be reduced to a nominal fee to take care of the cost of plates and perhaps the expenses of policing the highways? It is my opinion that such a conclusion is entirely unjustified. While the gasoline tax should doubtless be called on to produce a large proportion of the revenue derived from automobile users, there is a distinct place for the registration tax if the burden is to be fairly distributed among the owners of various classes of automobiles. On page 429 of the proceedings of the seventeenth annual conference on taxation under the auspices of the National Tax Association, occurs the following from the report of the committee on highway finance:

> Registration taxes appear to be necessary, even where gasoline taxes are in effect, in connection with the regulation of motor vehicle ownership and operation. They also are useful, because they can be devised to take more fully into account the influence of weight of car, weight of load and type of tire on highway wear and tear, than does fuel consumption. A further factor in favor of the levy of registration taxes, even when gasoline taxes are levied, is that highways in general are constructed on a scale sufficient to accommodate the peak load of traffic and an automobile which is in the garage most of the year, and therefore consumes little gasoline, but is operated on the highways when traffic is at its peak, escapes its due share of taxes if it is taxed only on its gasoline consumption. A greater measure of uniformity between the states on the bases used for levying registration taxes is, however, highly desirable. Gross weight, by which is meant the weight of the vehicle loaded with a standard load, is the best, as it is the simplest base. Where weight or gross weight is used as the basis of taxation, your committee recommends that the rate of tax, per unit of weight, should be graded upwards as weight increases, the graduation of rates to be determined on the basis of engineers' tests of the comparative wear and tear on the roads and use of road space per ton of different weight vehicles.

While the committee has followed essentially the recommendations which I submitted to it in a memorandum in the spring of 1924, it seems to me that one might go a step further than it advises, and make the graduation more rapid than the tests of comparative wear and tear on the average roads would suggest. Moreover, I would eliminate the idea of graduation of a weight tax in proportion to the use of road space per ton of different weight vehicles, because it is impractical.

But why should graduation be more rapid than the increase in destructiveness on the average road as the weight of the car increases? Would that not mean placing an undue burden on the owner of a particularly heavy motor car? Consider, in answer, the following case. A truck having a gross weight of 10 tons may, on the average roads of the state, be two and one-sixth times as destructive as one having a gross weight of 5 tons. If the gasoline tax is levied at the rate of 3c. a gallon and the light truck consumes 1,000 gal. annually while the heavy one requires 1,500 gal., the tax will amount to

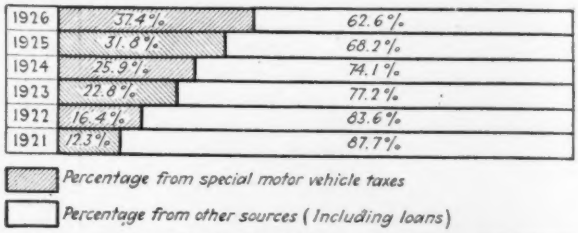


FIG. 1—PERCENTAGE OF TOTAL HIGHWAY REVENUE FROM MOTOR VEHICLE TAXES AND OTHER SOURCES

$30 in the first case and $45 in the second. If the registration tax on the first truck is made $30 and that on the second two and one-sixth as much, or $65, the total tax levied, gasoline tax plus registration tax, will amount to $60 on the truck having a gross weight of 5 tons and $110 on the one having a gross weight of 10 tons. That is, the total tax on the truck that is two and one-sixth times as destructive will be only one and five-sixths times as much as on the lighter truck. The registration charge must be made much more than two and one-sixth times as heavy, $85, if the total tax burden is to be cut and one-sixth as much as the burden on the operator of the lighter car. In general, then, the gasoline tax burden increases less rapidly than the increase in destructiveness of the car on the road, and hence the registration tax, if it is to be most useful, must offset that lag.

The case is even clearer when it comes to graduation on the basis of the character of the tires. A truck of 5 tons (gross weight) may be equipped with solid or with pneumatic tires. The gasoline consumption with solid tires is perhaps 10 per cent more than with pneumatic. But impact—a fairly accurate measure of what the wear may be expected to be under ordinary circumstances—will be about three times as great with the solid tires (Bureau of Public Roads data). It will be necessary, therefore, if the total charge is to be in proportion to the damage to the roads, that the registration tax be made more than three times as great on solid as on rubber-tired vehicles. If gasoline consumption in the case of the pneumatic-tired truck is 1,000 gal. a

year, and that on the solid-tired one is 1,100 gal.—a very generous allowance—and the gasoline tax rate is 3c. a gallon, the total revenue collected by means of the gasoline tax will be $30 in the one case and $33 in the other. Assume that the registration tax is $30 on the machine equipped with pneumatic tires. If it is made $90 on the car equipped with solid tires, the total tax, registration and gasoline, is $60 in one case and $123 in the other. Thus the total tax is only about twice as much on the truck with solid as on the one with pneumatic tires. To put the situation positively, the registration tax would have to be $147, or nearly five times the rate on the pneumatic-tired truck, if the total tax is to be three times the tax on the car equipped with pneumatic tires. In other words, if, on a car equipped with pneumatic tires, the registration tax in a given state is about equivalent to the average gasoline tax on a car of the same size, the license charge should be five times as much on a vehicle using solid tires.

If a schedule of rates for a registration tax be constructed on the basis of principles suggested above for a state having a three-cent gasoline tax, it might appear as follows for four-wheeled internal combustion engine cars with pneumatic tires:

Cars having a gross weight of 2 T. or less	$9
" " " " " 3 T. or more than 2 T.	15
" " " " " 4 T. " " " 3 T.	22
" " " " " 5 T. " " " 4 T.	30
" " " " " 6 T. " " " 5 T.	39
" " " " " 7 T. " " " 6 T.	49
" " " " " 8 T. " " " 7 T.	60
" " " " " 9 T. " " " 8 T.	72
" " " " " 10 T. " " " 9 T.	85

1. The tax on vehicles equipped with solid tires shall be five times the rates specified for cars equipped with pneumatic tires.

2. Trucks having six wheels with axle spacings of at least 40 in. shall be subject to 60 per cent of the tax to which a vehicle of the same gross weight and tire equipment would be subject. (According to the findings of Teller—The Six-Wheel Truck and the Pavement, *Public Roads*, October, 1925—the tensile deformation is only half as much on concrete when the truck has six wheels, but there are other wearing factors which would be of importance on many roads.)

3. Trailers shall be taxed at the same rate as motor vehicles of the same weight and tire equipment.

4. Motor cycles shall be taxed at $5 each or at $9 if operated with a side car.

5. Vehicles propelled by steam or electricity shall be taxed at twice as much as a vehicle with similar tire equipment and of like weight which is propelled by an internal combustion engine.

It seems to me that in most states it would be wise to prohibit the use of vehicles having a gross weight of more than 10 tons except on city streets and occasionally on other specified highways. Such a provision would apply to less than 2 per cent of the motor trucks used and would make unnecessary much of the heavy road construction otherwise required. If such action is not taken, it is possible that the rates on still heavier vehicles ought to be increased more rapidly than would be the case if the simple method illustrated above were used. It should be remembered, however, that vehicles of heavier gross weight would normally be equipped with solid tires and that multiplying by five will increase the total tax more rapidly at the high rates, because the registration charge would be much larger than the annual average gasoline tax.

If motor vehicles with metal tires are permitted on the roads, it will be necessary to make rates on them heaviest of all. The principle discussed above should apply in this case. Probably the application would involve a tax of roughly twice that levied on vehicles with solid tires or ten times that levied on those having pneumatic tires. Graduation to take care of metal-tired vehicles of less than two tons gross weight may be desirable.

Perhaps it will be worth while, in most states, to step up graduation by half tons, thus securing increased refinement. Or graduation might, if desirable, be made still less abrupt by steps of only one-fourth ton.

Emphasis should be placed on the fact that it is not intended to suggest what rates should be charged in any state. Those used for illustrative purposes are heavy and would be unnecessary in most states. The insistence of this paper is that rates should bear a certain relationship to each other, not that they should be at

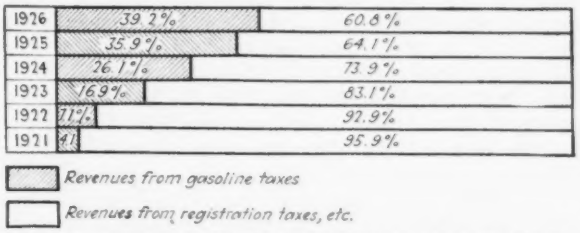


FIG. 2—PERCENTAGE OF MOTOR VEHICLE REVENUES FROM GASOLINE AND FROM REGISTRATION

any particular level. The principle involved is analogous to that in the income tax, where the rates are graduated very steeply on higher incomes to offset the regressiveness of consumption taxes. In the case of the motor vehicle taxes, it is a matter of offsetting the fact that gasoline taxes increase—with larger sized cars—less than in proportion to the increased destructiveness by having the registration tax increase more than in proportion to increased wear and tear on the road.

U. S. Water Power Increases 544,000 Hp.

THE total capacity of water wheels in power plants in the United States on Jan. 1, 1927, was 11,721,000 hp., an increase of 544,000 hp. for the year 1926, according to a report issued by the Geological Survey and the Federal Power Commission. This is an increase of 7,800,000 hp. or an average of 460,000 per year since Jan. 1, 1910. The 1926 figure was less than that for 1923, 1924 and 1925, but greater than that for other years except 1913.

The total capacity of prime movers, water wheels, steam engines and turbines, and internal combustion engines in public utilities, manufactures, mines and quarries (locomotives, motor vehicles and water craft not included) is estimated from data published by the Bureau of the Census for 1923 and previous years as 56,500,000 hp., an increase of 26,000,000 hp. since 1910. On Jan. 1, 1910, water wheels constituted 13.7 per cent of the total capacity of prime movers, and on Jan. 1, 1927, they constituted 20.7 per cent, showing a comparatively small but increasing proportion of water power development.

California, which became the leading state in developed water power during 1925, continued its first place on Jan. 1, 1927, leading New York State by about 160,000 hp. The state of Washington which has held third place since 1921, was displaced by Alabama, and South Carolina displaced North Carolina in fifth place.

Financing the Baltimore Sewerage System

Practically Entire System Has Been Built Since 1906 at Cost of Over $50,000,000 Raised by Bonds—Detailed Summary of Annual First and Maintenance Costs 1916-25

By M. J. Ruark and C. E. Keefer
Sewerage Engineer and Engineer of Sewage Disposal, respectively, Bureau of Sewers, Department of Public Works, Baltimore, Md.

LITTLE is known of the early efforts to finance and build sewers and drains in Baltimore. In all probability the first drains were built in that section of the city immediately adjacent to the harbor. These were most likely planned with little thought for the future, and were replaced by larger structures as the city grew. They were later extended into new sections of the city, and the semblance of a sewerage system began to appear. But these improvements even as late as 1900 had reached only a preliminary stage of development. That there was a demand for a sewerage system is apparent by the numerous engineering reports on the problem from 1862 to 1899. In a city the size of Baltimore some drainage facilities were necessary and were consequently provided. These consisted of several storm drains, which extended from the harbor front into the heart of the city. These drains on the whole were of ample size and well built. Many of them are still giving good service. They also received the discharge from a few sanitary sewers, but most of the buildings—about 90,000 in all—were provided with privies and cesspools. The major portion of the sewerage work done by the city previous to 1906 was financed by money obtained from the sale of bonds. Some work, however, was paid for out of the general tax levy. There were a few small sanitary sewers, most of which were built and owned by plumbers or private individuals.

Causes of Delay—That Baltimore was one of the last large cities to build a complete sewerage system is well known. Several reasons have been attributed. First, a good deal of the soil of the city was sandy, and was especially suitable for the use of cesspools. Some opposition to the building of a sewerage system came from an outside source. The state constitution requires that loans for sewerage improvements be authorized by the state legislature. The representatives from the counties, which had an overwhelming majority in this body, viewed with great concern the building of a sewerage system and the discharge of sewage into Chesapeake Bay with the consequent menace to the oyster industry. Furthermore, the city is situated on a land-locked body of water with the result that it would have been impossible to dispose of the sewage by dilution as did many other large cities. Moreover, the city in many ways showed little of that progressive spirit which was predominant in most large American municipalities.

But the adoption of modern improvements had to come. The first successful step to provide the city with a comprehensive sewerage system was taken in 1905 when the state legislature passed an act authorizing the expenditure of $10,000,000 for a sewerage system. Several reasons have been attributed for this action. Those that seem most significant are the Baltimore fire in 1904, which had a great awakening influence, and the gradual education of the populace to realize the obnoxious and insanitary conditions in which they lived. Within a few years after work on the sewerage system was begun, it became apparent that $10,000,000 was far too small a sum to sewer the city completely. A second loan of $10,000,000 was therefore authorized in 1911, and later a third loan of $3,000,000. These funds were practically all expended by the end of 1916. The work done by means of these loans did much to correct insanitary conditions. Large sections of the city, however, remained unsewered. Had it not been for the war, it is likely that efforts would have been made to obtain authority at the 1918 session of the legislature to float additional bond issues. During this period a few sanitary sewers were financed and built by private individuals, usually developers of large real estate projects.

Comprehensive System—In January, 1919, the city annexed 59.74 sq.mi. of territory from two adjoining counties. There was an immediate demand for sewerage service and other improvements in the annexed area but sufficient funds were not available for this work. Construction of sewers on the assessment basis had never been adopted. It was, therefore, necessary to get authorization from the state legislature in 1920 for another loan. A large committee of prominent citizens was appointed by the mayor to report on the amount of money needed for general improvements, including sewerage work, particularly in the newly annexed territory. As a preliminary to this report the sewer division of the city estimated that $25,180,000 would be needed to complete the sewerage system. This estimate included financing those sewers which would provide for future growth until 1930. The outcome was that the state legislature sanctioned a $26,000,000 loan. Of this sum $8,000,000 was for sewerage work, and the remainder was for water-works, highways and other improvements. Again in 1923 another loan of $10,000,000 was authorized. Nearly all of the first loan and approximately one-half of the second have been spent up to the present time. An additional appropriation of $10,000,000 has been authorized by the legislature of 1927 but this must be ratified by the people. A total of $41,000,000 has been obtained by loans since 1905.

The number of buildings connected to the sanitary sewers tributary to the sewage-works is shown in the chart. The first building was connected Oct. 27, 1911. In some cases buildings are connected to sanitary sewers which discharge into storm drains or water courses. Such an arrangement is only temporary until extensions are made to the sanitary sewerage system.

Commissions Supervising Sewerage Work—With the exception of the last $10,000,000 loan the expenditure of all of the previous loans was under the general control of commissions. The work done from 1906 to 1916 under the first three loans, totaling $23,000,000, was under

the supervision of a sewerage commission. This body consisted of seven members, who were appointed by the mayor and were paid for their services. They in turn selected a chief engineer, who with a large personnel functioned as a group in building the sewerage system. There was practically no connection between this commission and the rest of the city government except through the mayor, who was an ex-officio member of the commission. It had full authority over the building of the sewerage system but no power to make purchases or award contracts exceeding $500, to decide matters of a legal nature, or to determine the amount of money to be spent annually.

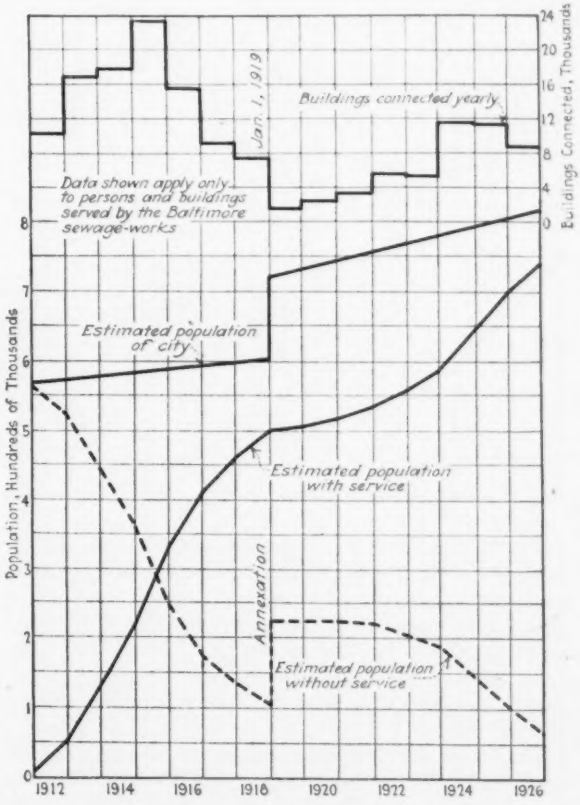
It is believed that the putting of the work under the control of a commission was at that time a wise step. Both political parties were represented on the commission, the members of which were prominent citizens. The result was that the whole project was generally free from political entanglements. Some felt that the work should have been under the direction of one of the existing city departments, but it is now considered that the results accomplished by the sewerage commission amply justified its establishment.

When the $26,000,000 loan was authorized in 1920, it was provided that the funds be expended under the direction of a commission to be appointed by the mayor. This commission holds frequent meetings and allots funds for the various improvements, including sewerage extensions. The commission consists of five members, prominent in business and professional circles. The design and the construction of sewerage improvements are under the supervision of the Bureau of Sewers, a division of the Department of Public Works. This policy has many advantages over that of establishing a separate engineering department. As this bureau has charge of the operation and maintenance of the sewerage system, the experience thus acquired has been useful in guiding future designs. Numerous features in the design of the sewers, demonstrated by actual practice to be useless or inadequate, are no longer used. Experience has, moreover, shown that usually the best results can be obtained by placing the design, construction, and operation of the system under the jurisdiction of one department. The engineer, for example, who is familiar with the operating difficulties encountered at a sewage-works is usually better able to adjust his designs to overcome the difficulties than one who has not had similar experience. Furthermore, design and construction are closely related. It frequently happens that a project cannot be built according to the plans. The final decision as to what to do should rest with one person, who can see what correlation the construction of the work bears upon the design.

Last Sewerage Loan—The expenditure of the last sewerage loan of $10,000,000 was vested in the Board of Estimates, the governing body of the city, which consists of the mayor, the president of the city council, the comptroller, the city solicitor, and the chief engineer of the Department of Public Works. This board passes upon what sewerage work shall be undertaken, and grants authority for all expenditures. The work is done by the Bureau of Sewers under the general supervision of the chief engineer.

The act of the state legislature empowering the city to extend its boundaries in 1919 also contained a clause which required the city to purchase all private sewerage systems in the annexed territory. Although most of these sewers, drains and treatment works were poorly designed and constructed, the city had to buy them. Up to the present time the purchase prices have been mutually agreed upon.

Advantage of Financing Sewerage Improvements by Loans—In some respects the financing of sewerage improvements by loans is decidedly simple, provided the borrowing power of a community is such that funds can be raised. Authorization for the loans is obtained in several ways, depending upon local statutes. In some instances a bill has to be passed by the state legislature, and in other cases only a favorable vote of the people



SEWERAGE SERVICE IN BALTIMORE, 1912-26

is required. After these preliminaries, bonds are sold and money then becomes available. Where sewers are built on the assessment plan, considerable bookkeeping and record work is necessary. The overhead costs are usually high, and there are constant disagreements with property owners as to the fairness of charges. The financing of sewerage projects by loans, the interest and sinking fund charges of which are paid for out of general taxation, is generally recognized to be the most satisfactory method where the work is beneficial to the public as a whole. Such is the case when sewage-works, pumping stations, intercepting and trunk sewers and storm drains are constructed.

Disadvantages of Financing Sewerage Improvements by Loans—Where small lateral sewers are built by money obtained from loans the imperfections of such a method are apparent. In Baltimore, for example, the obtaining of authorization to float loans is a slow process. The first necessary step is to prepare and present a bill to the state legislature. Even though

there is a need for sewerage improvements, it is possible that those members who do not represent the city may be unwilling to give the bill their support. And as the state legislature meets only once in two years, the project may be delayed until some future session grants the necessary authority. In case the matter progresses thus far, there is a possibility that the project might be defeated, as a referendum vote is required.

Another disadvantage in financing sewerage improvements by loans is that the interest and sinking fund charges are usually obtained from the general tax levy. Everyone, therefore, has to pay a portion of the charges whether or not he is directly benefited. There are almost always sections of a large city which are not sewered. The dwellings in these localities usually have cesspools or privies, which are in every respect inferior to modern sewerage improvements. The property owners, in addition to having the inconvenience and expense involved in antiquated facilities, have to pay their share of the expense of the loans, often for a long period of time.

Occasionally a sewerage project will be financed by means of a loan, and in the course of time the improvement must be abandoned or rebuilt before the loan has reached maturity. It is not sound finance to pay for something which has no longer any value. For this reason the period at the end of which bonds mature should never be longer than the average useful life of the work done.

When funds are available from loans, money may be needed for other improvements. Under such circumstances there is an inclination to use some of the funds intended for sewerage projects for other purposes. Frequently employees, who are paid by money from loans, will be doing work that has no connection with the improvements financed by the loans. It is sometimes difficult to determine whether a certain project should be paid for out of funds provided for maintenance purposes or whether it should be financed from loans. When the former funds are inadequate, there is a temptation to use the latter for maintenance purposes. By using appropriations that were originally intended for new work, the impression is often created that considerable economy is being exercised in maintaining the sewerage system. Such a policy should be condemned.

Cost of Financing Sewerage System—The total cost of financing the Baltimore sewerage system from 1916 to 1926 is given in Table I. Previous to 1916 a large part of the system was still under construction, and the quantity of sewage collected and treated was small. The total yearly sewage flow increased gradually from 14,374 m.g. in 1916 to a peak of 20,096.08 m.g. in 1919. After the latter date the flow diminished even though the number of persons served increased. This condition was the result of an intensive conservation campaign conducted by the bureau of water supply. The average daily sewage flow consequently decreased from 110 gal. per capita in 1919 to 81 gal. in 1926. The result has been that the Eastern Ave. sewage pumping station, which lifts approximately 28 m.g.d. of sewage from the business and industrial sections of the city, has been operated at a lower cost. It is doubtful whether the decrease in the sewage flow has lowered the cost of operating the sewage-works and the rest of the sewerage system.

As is apparent from the table, the interest and sinking fund charges increased in 1922 when bonds amounting to $8,000,000 were sold. The total annual first cost per capita served decreased from $2.72 in 1916 to $1.95 in 1921 to $2.40 in 1922 and to $2.21 in 1925. The total operating cost of sewage treatment has been increasing since 1916 due to a greater sewage flow, but the cost per capita served has varied but little from an average of 15c. per year. The cost of operating the sewage pumping station has also increased. From 1919 to 1922, inclusive, the cost was unusually high as the cost of coal was more than in other years. The total expenditure for financing the sewerage system, including first cost and operating and maintenance charges, has varied from a minimum of $2.60 a year per capita to a maximum of $3.27, with an average of about $3. Of this amount an average of approximately $2.25 has been spent yearly to cover the first cost of the improvements, and about 75c. for operation and maintenance. The sum of $3 a year capitalized at 6 per cent amounts to an investment of $50. An average annual levy of 28c. on each $100 of taxable property has been necessary to finance the sewerage system. The total taxable basis of the city has increased from $298,095,370 in 1916 to $930,958,658 in 1926. Each cent increase in the tax rate for 1926 was equivalent to an increase of $93,095.87 collected. The full tax rate of the city from 1916 to 1926 has averaged $2.55 per $100 of taxable property. About 11 per cent of the city taxes are, therefore, used to finance the sewerage system.

TABLE I—ANNUAL COST OF FINANCING THE BALTIMORE SEWERAGE

	Population*			First Cost				Operating		
Year	Total	Contributing Sewage	Sewage Flow, M.G.	Interest on Loans	Sinking Fund	Total	Cost per Capita Served	Sewage Treatment	Sewage Pumping	Sanitary Sewers and Storm Drains
1916	589,623	376,385	14,374.00	$884,392.50	$140,000.00	$1,024,392.50	$2.722	$37,290.58	$41,356.99	$95,019.72
1917	594,638	438,000	16,199.83	883,132.50	142,000.00	1,325,132.50	2.340	46,686.76	46,157.34	57,041.89
1918	599,653	479,295	19,284.78	881,805.00	143,000.00	1,024,805.00	2.138	55,193.67	69,723.45	96,555.35
1919	728,148	501,540	20,096.08	880,387.50	146,000.00	1,026,387.50	2.046	68,112.70	92,864.10	145,896.30
1920	739,506	511,250	19,074.23	878,880.00	147,000.00	1,025,880.00	2.007	74,420.27	112,993.73	240,745.62
1921	750,864	525,035	17,015.72	877,327.50	148,000.00	1,025,327.50	1.953	92,080.47	115,186.93	303,897.48
1922	762,222	546,830	17,333.57	993,692.11	317,384.61	1,311,076.72	2.398	114,785.17	93,030.03	271,351.99
1923	773,580	573,820	17,581.21	1,042,543.07	327,000.00	1,369,543.07	2.387	109,800.74	86,043.33	309,322.44
1924	784,938	616,025	19,581.82	1,048,802.88	336,923.07	1,385,725.95	2.249	110,016.29	83,658.98	415,450.49
1925	796,296	673,240	20,108.30	1,138,595.76	349,153.84	1,487,749.60	2.210	114,299.21	89,520.09	374,958.42
1926	807,654	722,610	21,368.45	1,310,314.03	370,153.84	1,680,467.87	2.326	108,608.72	81,694.25	367,231.44

*Estimated as of July 1 of each year.

Estimated Cost of the Sewerage System—In 1923 the mayor appointed a commission of engineers and prominent business men to recommend the reorganization of the various departments of the city in order to adopt more economical and efficient methods. One of the commission's duties has been the valuation of all land, buildings, improvements and utilities owned by the city. It is thought that the facts disclosed by this valuation will be a factor in determining the borrowing capacity of the city for future improvements. An estimate based on prices as of Jan. 1, 1926, was there-

fore made of all sewerage improvements completed by that date (see Table II). The valuation includes money spent for real estate and overhead; moreover, deductions are made for depreciation. With Table II as a basis, the cost per capita of the sanitary sewerage system has amounted to $40.84, and the storm water system $32.86 with a total cost $73.70.

The Financing of Sewers by Private Persons—During the 10-year period that the sewerage commission was at work, there were many private individuals who desired to have sanitary sewers built—in most cases for new real estate developments in various parts of the city. The commission declined to finance this work, because it felt that its activities should be confined to those sections that were developed but unsewered. The real estate operators were therefore obliged to build the sewers at their own expense. The commission required that all sewers be constructed according to its general comprehensive plan and under its supervision.

SYSTEM FROM 1916 TO 1925

Cost	Cost per Capita Served	First Cost and Operating Cost	Per Capita Served	Per $100 Taxable Basis
Total		Total		
$173,667.29	$0.461	$1,198,059.79	$3.183	$0.30
149,885.93	.342	1,175,018.43	2.683	.28
221,472.47	.462	1,246,277.47	2.600	.29
306,873.10	.612	1,333,260.60	2.658	.29
428,159.62	.837	1,454,039.62	2.884	.31
511,164.88	.974	1,536,492.38	2.926	.30
479,167.19	.876	1,790,243.91	3.274	.28
505,166.51	.880	1,874,709.58	3.267	.27
609,125.76	.989	1,994,851.71	3.238	.25
578,777.72	.860	2,066,527.32	3.070	.24
557,534.41	.772	2,238,002.28	3.098	.24

Under this arrangement the real estate operators also had to pay for plans and inspection. A franchise charge of 25c. per lin.ft. for the use of public thoroughfares was made together with a charge of $25 in those cases where the sanitary sewers connected with a storm drain or other temporary outlet. In many instances these supplementary charges were considerable, amounting to as much as 50 or 60 per cent of the construction cost. On the other hand it was agreed that the city would purchase these private sewers, when the sanitary sewerage system was extended to meet them, at the cost of constructing similar sewers less the franchise and tapping charges. The commission soon learned that these obligations to purchase sewers were accumulating, and would in time involve a large expenditure. They finally declined to make any additional agreements of this kind.

This plan of financing private sanitary sewers was superseded by another method in use at the present time. Preliminary surveys and final plans are now prepared by the Bureau of Sewers. These plans are made to conform to the general layout of the sanitary sewerage system. The sewers are then built according to the specifications and under the supervision of the above bureau. No engineering or supervising fees are collected. No franchise charge is levied for the use of public thoroughfares or for connecting the sewers with temporary outlets such as storm drains. The builder bears no expense other than the actual cost of constructing the sewers. In rural sections where dwellings are being erected, the construction costs are usually less than if the territory were developed. Improved pavements do not have to be torn up; interference with other sub-surface structures is not encountered; and where the grades of proposed streets are established at elevations above the original ground, the sewers can be laid in shallower trenches.

If these sewers connect with the sanitary system, the builder agrees to deed them to the city. If they discharge into a stream, storm drain or other temporary outlet, the owner retains his ownership of them until the sanitary system is extended by the city to intercept them, when they will become the property of the city. At first sight this plan might seem unfair. When it was first adopted, some builders opposed it. Now, however, no objections are being made. The reasons for adopting such a plan are apparent. If private individuals were allowed to lay sewers haphazardly to conform to no general plan, few of these sewers could later be made a part of the general sewerage system. Poor alignment and flat grades would result. The sewers would be so shallow that they would be in the way of future sub-surface structures, and would not serve the plumbing fixtures in the cellars and basements of many houses. Consequently it would be necessary for the city to build new sewers, and the owners would be put to the expense of making new connections. Experience has shown that private individuals usually make exorbitant charges for granting the privilege to connect to their sewers.

Those who build sewers under this plan are naturally relieved of all expense connected with maintaining them. Builders of course include the cost of the sewers with the cost of property being developed. The purchaser is thus reasonably certain that no assessments will be levied, nor will he be put to any expense in rearranging or connecting his house sewer to other sewers. All trunk sewers are designed and built at the expense of the city, but when a private individual is required to construct a sewer larger than necessary, the city reimburses him by a sum equivalent to the difference in cost of the large sewer and the sewer he would have to build under ordinary circumstances. The above plan has been effective since 1916 and has worked satisfactorily.

TABLE II—VALUATION OF THE BALTIMORE SEWERAGE SYSTEM AS OF JAN. 1, 1926

Sanitary Sewerage System		
Back River sewage-works	$5,800,000	
Eastern Ave. pumping station	2,190,000	
Sewers built by the city	22,370,000	
Sewers built by private interests	2,390,000	
		$32,750,000
Storm Drainage System		
Drains built by the city	$25,780,000	
Drains acquired by purchase or gift	230,000	
Drains built by public utilities corporations	170,000	
Drains obtained by other sources	170,000	
		$26,350,000
		$59,100,000

Further Policies—It is generally recognized that building the entire sewerage system of a city with money obtained from bond issues is not entirely satisfactory. Only two of the 18 largest cities in the United States follow this policy, one of which is Baltimore. In spite of the disadvantage connected with this method, public inertia is such that it is difficult to adopt any other plan. Perhaps the quickest way to bring about a change would be by educating the public.

With conditions as they exist at Baltimore, it is the opinion of the writers that major sewerage projects should be financed by bond issues while lateral and house sewers should be paid for on the assessment basis by the properties benefited. Various other means

of financing the operation and maintenance of the system are available—as making a tapping charge for each building connected to the public sewer, or basing a charge upon the amount of water consumed, or collecting funds from the general tax levy, or one or more combinations of these methods. The disadvantage of obtaining money from the general tax levy is that city authorities may not provide sufficient funds to operate and maintain the sewerage system properly. Basing charges on the quantity of water used by each property owner has much to be said in its favor. Persons who use the most water usually receive the most benefit from the sewerage system. Such is not the case, however, under those exceptional conditions where the spent water does not return to the sewers as, for example, in a railroad yard. Then, this plan is only applicable where water meters are in general use. The practice of making a tapping charge when house sewers are connected to the main sewer provides funds which can be used either for construction or operation purposes. Other novel and interesting ways of charging for sewerage service are to levy a fixed sum per building or to base the charge on the number of plumbing fixtures. Local conditions and laws may limit or govern the method in vogue in any given community. Standardization, though not vital, is to be desired. Vast sums of money are being spent annually both to build and operate sewerage systems. Since many cities have not yet solved their sewerage problems, especially sewage disposal, it is of vital importance to adopt the most scientific and equitable method of obtaining these funds.

The Bureau of Sewers is a part of the Baltimore Department of Public Works, of which B. L. Crozier is chief engineer. Acknowledgments are due to the Efficiency and Economy Commission which prepared the cost estimate given above.

Testing Concrete Workability

Study of devices for testing workability of concrete has been carried on for some time at the Bureau of Standards. A rod penetration apparatus was described in *Engineering News-Record* Dec. 9, 1926, p. 955. A new method of testing workability has now been devised and a preliminary series of tests has been completed, as reported in the "Technical News Bulletin" of the Bureau. The new apparatus is constructed as follows: A flexible mold 6 in. high and 8 in. in diameter was made of phosphor bronze $\frac{1}{8}$ in. thick. The bottom edge of the cylinder was ground to a plane and placed on plate glass. The top of the cylinder was fitted with four small rollers so that a weighted frame could be placed on them to hold the cylinder down on the glass plate. Two 2x4-in. oak bars were placed on rollers and parallel to each other outside of the cylinder. These bars were attached by pulleys to a load pan. A small batch of concrete is mixed and placed in the cylinder to the depth of 5 in. A weight is placed in the load pan and the cylinder of concrete is squeezed between the two bars. The reduction of diameter of the cylinder is taken as the measure of the workability of the concrete. This reduction is greater, the more workable the concrete. In the field, a concrete mix with a $\frac{1}{2}$ to 1-in. slump is dry and difficult to handle, but a small increase of water increases the ease of shoveling. Curves were drawn showing relation of water content to workability.

Locating Gravity Pipe Lines for Gathering Crude Oil

One of a series of articles on Oil Field Engineering

By L. E. Davis
Engineer, Prairie Pipe Line Co., Independence, Kansas

PROBABLY eighty per cent of the crude oil received at the refineries is pumped through pipe lines which have their beginning at the producer's tanks. Flowing by gravity or, if necessary, being pumped to small so-called gathering line pumping stations, oil is first received in the stock tanks and then pumped through what is termed a discharge line to the nearest point on the main or trunk pipe line.

Location—Where a choice is possible between cultivated and timber or pasture lands it is usual to select

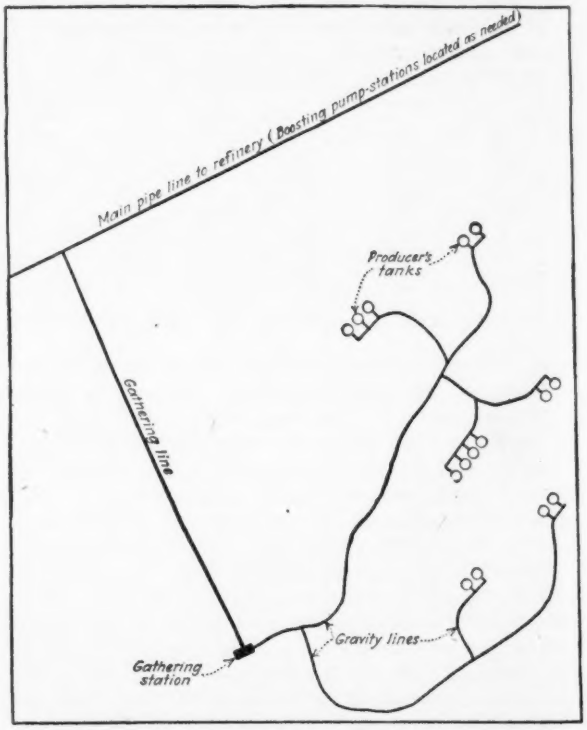


FIG. 1—DIAGRAM OF AN OIL PIPE LINE SYSTEM

the route through the uncultivated land. Disadvantages of the route through the cultivated land are the high cost of right-of-way and the damage to growing crops. Since the line must be kept at least eighteen inches under ground at all points through a cultivated field, it will also mean an increased amount of ditching. On the other hand, a route through cultivated land usually has the advantage of easier construction and a lower cost for clearing a right-of-way. Factors which also uneconomically affect a route through uncultivated land include difficulty of construction, necessity of bridging ravines, longer lines due to irregularity of the ground, and cost to clear right-of-way through the timber.

Whether the route is through cultivated or wild land, there is usually a choice between cutting through ridges to put the pipe down to grade, or going around the ridge, which will take more pipe but may take less excavation. Each case must be decided as it presents itself, and it is

therefore necessary that the surveyor be familiar with costs of pipe and of construction and excavation for the ditch. Stream crossings should be avoided wherever possible on account of damage to the pipe line by drift

FIG. 2—SUSPENSION BRIDGE CARRIES PIPE OVER GULLY

during floods. However, if a location can be found where the banks are high, the pipe may be suspended across the stream.

A preliminary line of levels with the transit or hand level with numerous side shots will locate the points which control the route and indicate the total fall. Bench marks can also be placed which will be convenient when the line is run. Topographical maps of the United States Geological Survey also help, but they are on too small a scale to indicate the route except in a most general way. The route should also be walked over before starting the actual survey.

Surveying Methods—Though extreme accuracy is not required, gravity line surveys must be free from serious error, must be made rapidly, and with good judgment. The producer is anxious for the pipe line connection, the cost of the line depends on the judgment used in locating the line, and serious errors in leveling result in poor operation and lowered flow capacity. The development of oil pools is usually rapid and time is important.

Gravity line surveys have the following objects: (1) To determine the most economical route; (2) to determine the amount of right-of-way which must be purchased; (3) to set the stakes giving line and grade for the construction of the line; (4) to provide maps and profiles as a permanent record of the line.

The surveyor will select and stake out on the ground the line which will give a uniform grade with the least cut or fill. By fill it is meant that the pipe will be supported by small trestles of wood or pipe. The survey notes will supply a schedule of cut or fill at each stake to be furnished the ditch contractor and those in charge of construction. The survey begins at the low end of the line; that is, at the pumping station or at the junction of the proposed line with one already laid. When the station is built, the suction pump is set low enough to pump out all gathering lines coming into the station. The gravity line is started out of the station at the elevation of the suction side of this pump.

A survey party consists of an instrument man who acts as chief of party, a rodman, a flagman, two chainmen, and one or more axemen. It is advisable to have a second instrument man so the chief of party may have more time to select the route and direct the flagman. The line consists of a series of tangents run with a transit, compass bearings only being recorded. The pipe is bent to fit the sharper angles and is swung around where the deflection angle is small. A 100-ft. chain is used for measurement and stakes set every 100 ft. or at every break in the ground. As soon as the stakes are set, levels are run and elevations recorded. Level notes and compass bearings are recorded on the same page for each station or plus, and on the opposite page notes are recorded on topography, the survey distance to each property line and section line, kind of crop, nature of soil, etc. When the survey line crosses a section line the distance to the section corner is measured, thus tying in the survey to the land lines.

As the survey progresses, a profile is drawn to check the grades which were tentatively established in the field. The line is run as low as possible, for this gives less difficulty with ravines which are more numerous farther back from the stream. The cuts and fills may be marked on the stakes at this time or, if desired, this can wait for the profile to be completed in the office.

While the line is being surveyed, the distance across each property is computed and furnished to the right-of-way agent who purchases the right-of-way and pays for

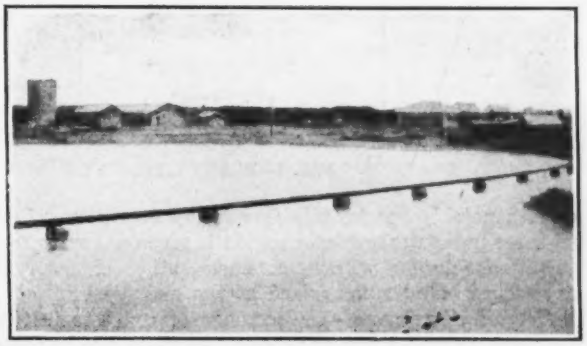


FIG. 3—HOW PIPE LINE CROSSES SHALLOW POND

damages to crops and land caused by construction of the line. This information is furnished on printed forms or diagrams showing the quarter section lines. When the survey is completed a profile is drawn and prints furnished the construction men as soon as possible. The cut or fill is marked on the profile for each stake, and from the profile they are marked on the stakes. A map on a scale of 2 in. to the mile is drawn showing the location of the line. A good scale for the profile is 1 in. = 400 ft. horizontal, and 1 in. = 40 ft. vertical. These scales indicate the degree of accuracy required in the survey. While the grades are run rapidly and rod readings taken only to the nearest 0.1 ft., yet errors are costly and a sag of a foot in the gravity line means poor operation. It has been found that a uniform grade is very desirable. On a line with poor grades the collection of air at the summits and water in the sags cuts down the flow capacity of the line.

Layout of Concreting Plants for Three Warehouses

Comparative Studies Give Broad Conclusions on Delivery Methods, Mixer Sizes, Chute and Buggy Distribution and Winter Concreting

By L. C. HAMMOND
District Manager, Parklap, Inc., Detroit, Mich.

PLANT arrangement, equipment schedules and performance on three separate but comparable buildings are contrasted in the accompanying plans and descriptive text. The buildings are all of the warehouse type, of reinforced concrete, and all constructed by the same contractor, Parklap, Inc., Detroit, Mich. One was in Detroit, one was in Toronto, and the third was in Montreal and required special provisions for cold weather concreting. The two others were concreted during the warm season. At Toronto there was, however, a notably special pile foundation operation. For all three buildings the information is given as condensed as practicable and without comment, all conclusions of experience being summarized at the end.

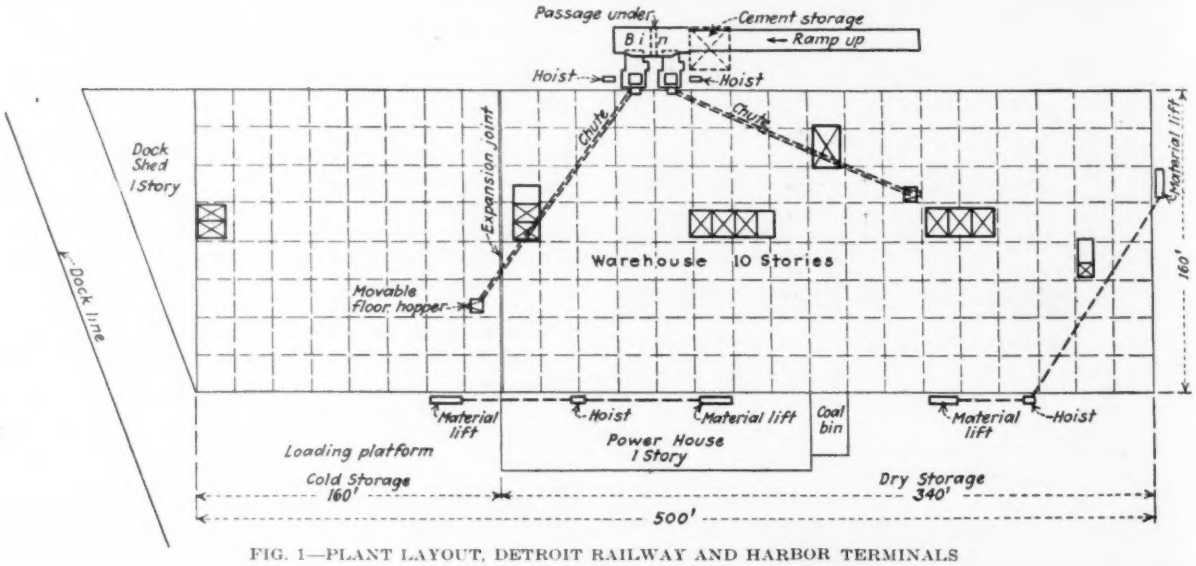


FIG. 1—PLANT LAYOUT, DETROIT RAILWAY AND HARBOR TERMINALS

Detroit Warehouse—The yardage of concrete in the Detroit warehouse proper was 42,000 cu.yd. and for the complete job 45,600 cu.yd. The plant designed to handle this yardage consisted of two 1-cu.yd. mixers, with concrete towers 220 ft. high. Each tower had a sliding frame and chuting system consisting of one cantilever suspended truss, and two extension chutes, by means of which it was possible to chute concrete to any part of the building, except 100 ft. at each end. The mixers were fed by two bins, each having a capacity of 150 cu.yd. of gravel mixture. This gravel was trucked to the bins on a wooden ramp having a grade of 16.3 per cent. Fig. 1 shows the entire plant arrangement.

The steel and forms were hoisted on skip hoists located at intervals around the outside of the building as shown by Fig. 1. There were also two tower hoists located in the elevator shafts in the building. These were used to hoist brick and miscellaneous materials. A 5-ton gasoline locomotive crawler crane with a 50-ft. boom was used throughout the job, and was found to be invaluable in unloading cars, hoisting materials to floors, and helping out in emergencies.

The concrete plant was designed to handle the 42,000 cu.yd. in the building, with the expectation that it would be necessary to pour 400 cu.yd. per day. The two plants were installed so that there would be no possibility of delay due to breakdowns. One plant was found to be sufficient to handle the yardage as fast as forms and steel could be laid. Two plants were necessary to prevent delays and occasionally handle an extra large yardage. At the latter end of the job the two plants were indispensable to pour in different places at the same time. Results obtained show that after the second floor was started and until the roof was completed, the average pour was 310 cu.yd. The record pour for one day was 735 cu.yd.

The contract for the Detroit warehouse was signed May 27, 1925. The roof was poured Dec. 4, 1925, and the building was turned over to the owners March 15, 1926. The general contract called for a 10-story concrete warehouse, having 800,000 sq.ft. of floor area, of which 232,000 sq.ft. was cold storage. There was also included 1,100 lin.ft. of dock, a transfer shed with 30,000 sq.ft. of floor area, and driveways, track construction and equipment necessary for a complete warehouse. Albert Kahn, Inc., was the architect and Moores & Dunford were consulting engineers.

Toronto Warehouse—The warehouse at Toronto had a total of 45,000 cu.yd. of concrete, with an additional 5,600 cu.yd. in driveways, power plant, etc. To take care of this yardage, there were installed two separate mixer plants, both plants being supplied from a common gravel stock pile by one derrick, as indicated by Fig. 2.

A double mixer plant was located on the dry storage side of the building, consisting of one ¾-cu.yd. mixer, and one 1-cu.yd. mixer, with two concrete towers, one tower 120 ft. high and the other 150 ft. high. In connection with this plant there were two gravel bins of 100 cu.yd. capacity. The mixer plant on the cold storage side of the building consisted of a 1-cu.yd. mixer with a 140-ft. concrete tower, and a 100-cu.yd. gravel bin for gravel mixture.

Both of these mixer plants were supplied with gravel mixture by means of a stiff-leg derrick with a 1½-cu.yd. clamshell bucket, so placed that the swing of the boom covered all three bins at one position of the boom. This derrick unloaded nine cars of gravel on three tracks and deposited it either in the bins or in a stock pile of 3,500 cu.yd. capacity. A crawler crane with a ¾-cu.yd. clamshell bucket was used in unloading and shifting cars, and keeping the stock pile filled. These two machines unloaded about 40 cars of material each day. The derrick unloaded an average of 29 cu.yd. per hour. It was necessary to work it in two shifts. The crane averaged 24 cu.yd. per hour and worked only one shift.

After the second floor slab was poured and until the roof was poured, an average of 500 cu.yd. of concrete was poured per day; on three occasions more than 1,000 cu.yd. of concrete were poured and the record day's pour was 1,186 cu.yd. On this record day, 44,000 sq.ft. of concrete floor was placed and the surface finished with a monolithic finish. All concrete on this job, with the exception of the power house roof was wheeled from hoppers at the towers. The maximum distance wheeled was 300 ft.

In addition to this plant, there were five skip hoists located around the outside of the building, and one small and one large panel hoist. These were arranged so that at least two of them could be operated from one hoisting engine and were used for hoisting steel, forms, etc., to the various floors. Inside the building there was also one car shifting machine, for moving the gravel and cement cars.

An unusual record was made on the pile driving. The contract included 10,000 wooden piles 28 ft. long, which went to solid rock. Four new drivers were built and in operation three weeks after the contract was signed, and the 10,000 piles were all driven in six weeks after driving was started. The average for the entire job was 6 piles per hour per driver, including delays. Two of the drivers were drop hammers and two steam hammers. The record for the drop hammers was 141 piles in 9 hours and the record for the steam hammers was 127 piles in 9½ hours. All the piles were jetted.

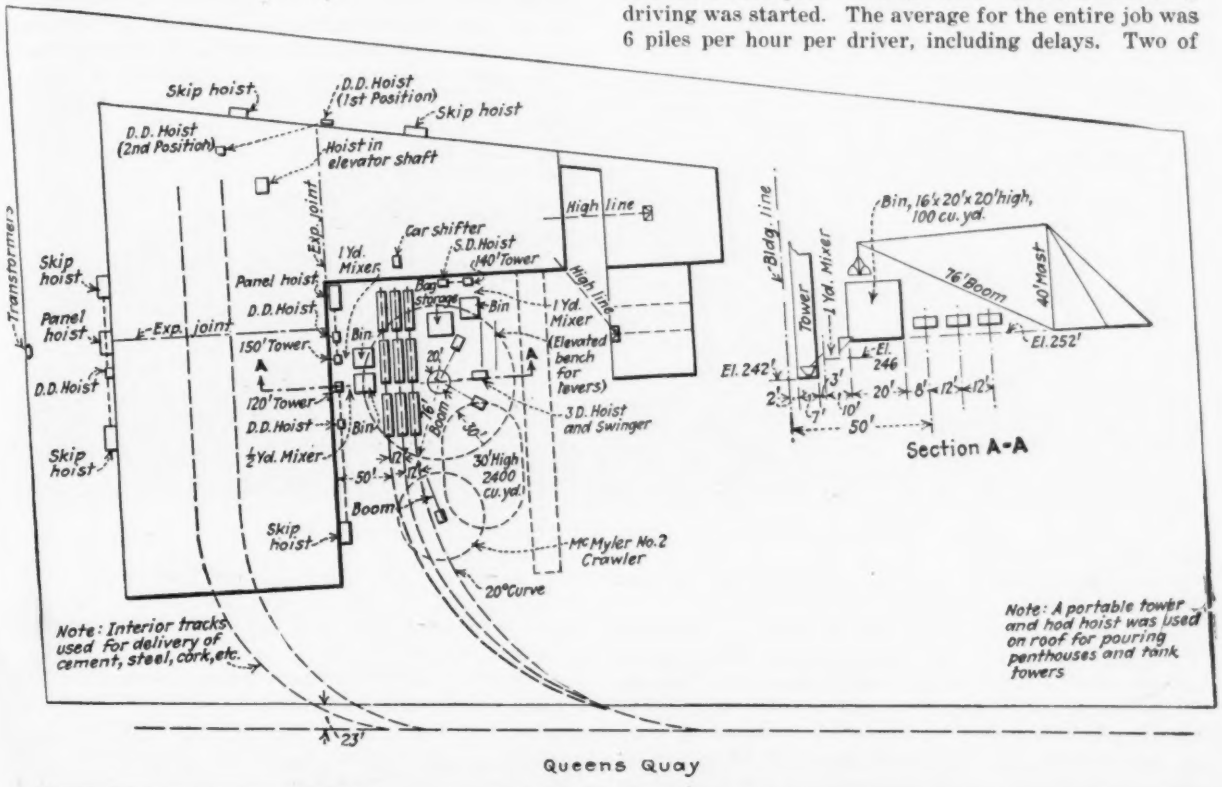


FIG. 2—PLANT LAYOUT, TORONTO RAIL AND HARBOR TERMINAL

The equipment on this pile driving consisted of four wooden A-frame skid-type drivers with 67-ft. leads. Two drivers were equipped with 7x10-in. double-drum engines, 45-hp. vertical boilers and Vulcan No. 2 steam hammers. The other two drivers were equipped with 7x10-in. double-drum engines with 40-hp. vertical boilers and 3,600-lb. drop hammers. For jetting purposes a central pumping station was erected, consisting of two 12-10-12-in. duplex pumps, 150 ft. line pressure, capacity 300 gal. per minute each. Each pump was equipped with a 35-hp. vertical boiler and a spare boiler of 35 hp. was also erected for emergencies. Fig. 4 shows the routing of the pile drivers. Whitney Brothers of Duluth, Minnesota, were the subcontractors on the piledriving.

The contract for the warehouse at Toronto was signed

April 28, 1926. The roof was poured Oct. 17, 1926, and the completed building turned over to the owners for occupancy Feb. 1, 1927. This warehouse was an eight-story concrete building, with a total floor area of 935,000 sq.ft. of which 201,000 sq.ft. is cold storage. The contract also includes a power house, a 75-ton ice plant, a small transfer shed, concrete driveways, track construction, and equipment required for a complete warehouse. Moores & Dunford were architects and engineers on this warehouse.

Montreal Warehouse—The yardage of concrete in the warehouse proper at Montreal was 29,000 cu.yd. and in the total contract 30,500 cu.yd. The layout of plant was determined by the fact that half of the building had to be completed by June 1, 1927, and there was only one place to erect the plant to build this. It was necessary to remove this plant before the building could be operated, so that the second plant had to be located in a different location, which would have been a better position for both plants if there had been time to complete the roof of the power house so that it could be used for a driveway.

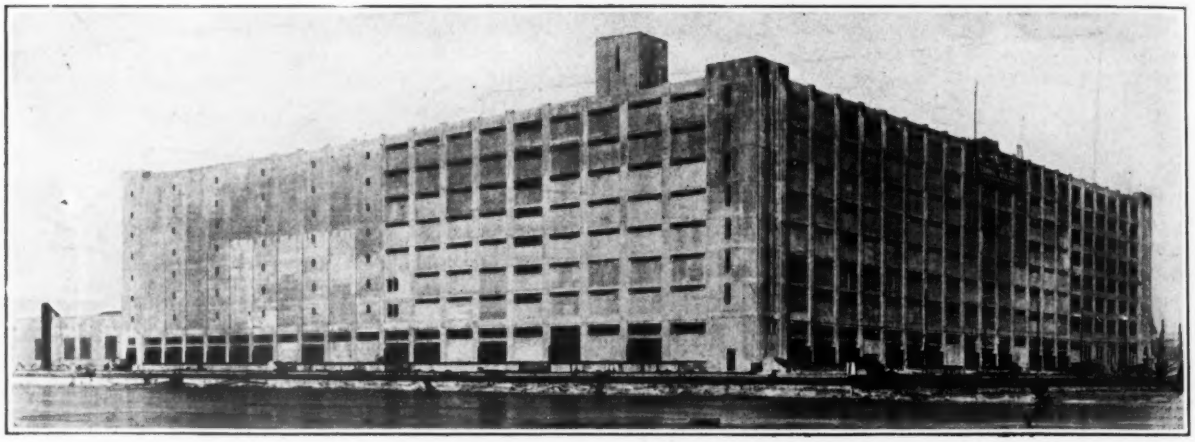


FIG. 3—ONE OF THE WAREHOUSES, INDICATING TYPE OF CONSTRUCTION

The first of the two plants consisted of a 1-cu.yd. mixer supplied with separate materials in bins above the mixer, with a capacity of 140 cu.yd. of stone and 65 cu.yd. of sand. These materials were delivered to the bins by trucks operating on a wooden ramp with a grade of 16 per cent. The cement was delivered by truck and the small quantity necessary was stored under the ramp, near the mixer. One concrete tower was used 140 ft. high. Fig. 5 shows the layout.

The second concrete plant was built after the power house was closed in and was located in the power house, the roof of the power house, which was designed as a driveway, being used for delivery by trucks, dumping sand and stone in two bins built over the mixer and in the power house area, which had a capacity of 140 cu.yd. of stone and 65 cu. yd. of sand. The mixer was a 1-cu.yd. mixer, and the tower was wood 140 ft. high.

The steel and forms were hoisted by means of four skip hoists and one panel hoist.

The schedule required that the second floor be poured by Dec. 1 and the roof by Feb. 20. The minimum temperature in Montreal during the months of January and February is below 10 deg. about half the time. An 80-hp. boiler was located near the concrete plant and pipe coils were laid in the bins to heat the stone and sand. The water was also heated and the concrete when it was deposited was at a temperature of above 75 deg. Calcium chloride was used in the water in a proportion of 2 lb. by weight of calcium chloride to each bag of cement.

As soon as several bays of concrete were placed and not more than one hour after it was placed, a canvas covering was laid over the concrete, supported by 4x6-in. timbers 20 ft. long resting on the column bars. On top of these 4x6's, 3x4's 23 ft. long were placed about 3 ft. on centers, and a canvas spread over these 3x4's so that the concrete was completely closed in at an elevation of about 18 in. above the floor surface. Four wooden sleeves were placed in the concrete slab located half way between each column through which the warm air from the story below kept this concrete up to a temperature of 72 deg. for a period of 48 hours. The heat on the floor below was produced by three salamanders in each bay burning coke.

After the concrete had been heated 36 hours it was necessary to start erecting column forms and the canvas

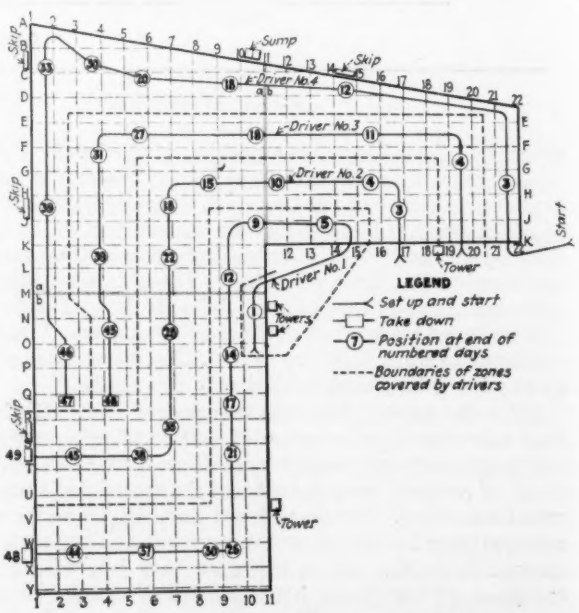


FIG. 4—PILEDRIVER ROUTING AND PROGRESS, TORONTO WAREHOUSE

protection was removed and about 12 in. of wheat straw was spread over the floor slab. The contractor made an arbitrary rule that all concrete must be kept heated for a period of three weeks to a temperature of about 50 deg. To do this it was found necessary to enclose the walls of three floors with canvas and keep one salamander going in each two bays for three weeks.

With the above precautions it was found possible to pour a floor in area 24,000 sq.ft. every 8 to 11 days, depending on the severity of the weather. A rule was made that concreting should not be started any morning when the temperature was below + 10 deg.

By various tests made at the job, it was found that calcium chloride with warm material would prevent freezing for a period of one hour when the thermometer was 10 deg. One hour was sufficient for the concrete to be deposited and covered up. From these tests it was decided that if the thermometer was below 10 deg. the

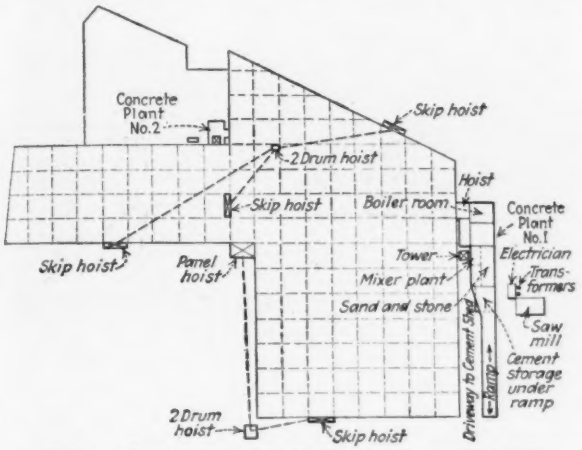


FIG. 5—PLANT LAYOUT, MONTREAL WAREHOUSE

material must be heated more than possible with the plant available.

On the cold storage section, which was split column construction, the walls were carried up with the floor slab. These walls eliminated the necessity of canvas on the sides of the building and the concrete in the walls themselves was protected by manure stuffed between the form sheeting and roofers nailed on the outside of the forms, so that a protection of about 8 in. of manure covered the whole area of these wall forms. This protection was permanent and hoisted up with the forms.

The contract for the Montreal warehouse was signed Sept. 16, 1926, and the foundations were completed Nov. 1, 1926. One-half of this warehouse will be turned over to the owner May 15, 1927, and the balance July 1, 1927. This contract is for a ten-story warehouse having a floor area of 576,000 sq.ft. of which 141,000 sq.ft. is cold storage. There are also included a power house, track construction, driveways, and equipment for a complete warehouse job. Moores & Dunford are the architects and engineers on this warehouse.

Conclusions—The results obtained on these three warehouses have convinced the contractor that a 1-cu.yd. mixer with a tower bucket sufficiently large to hold a full yard of wet concrete without spilling is the correct size plant, and that one plant of this size is large enough for such a job, but that when speed is necessary a second plant of the same size is warranted to help out.

The ramp method of loading bins is the most satisfactory when the material can be bought at the right price in trucks. The chuting system of distributing concrete is more expensive and more dangerous and the source of more delays than buggying. Placing concrete by buggies is less expensive than chuting when the distance from the tower is not more than 300 ft. and when laborers can be secured plentifully at 70c. per hour or less.

Concrete can be poured in flat slab jobs when the temperature is not lower than 10 deg. without danger and with a loss of speed of only two days per floor with one set of forms, provided calcium chloride, canvas, and heat are used intelligently.

The progress of a concrete job in cold weather is limited, not by the danger of freezing the concrete, but by the fact that efficiency and speed cannot be obtained from the carpenters working on the forms when the temperature is below plus 10 deg.

Fire Resistance of Hollow Tile

THE Bureau of Standards has completed its fire tests of hollow load-bearing wall tile. Some of the results of the extensive tests follow.

Effect of Grog—The walls of tile with no grog or only small amounts withstood longer fire exposures than those built of tile having 5 or 10 per cent grog.

Combustible Filler—Additions of combustible filler (sawdust) up to 15 per cent, especially to the dense burning clays, increase fire resistance. However, too large amounts may too greatly decrease the strength for load bearing tile.

Shell Thickness—Tests did not show appreciable difference in fire effects with an increase of shell thickness over that normally used, namely, $\frac{3}{4}$ to $\frac{7}{8}$ in.

Hardness of Burning—There is no advantage from the fire resistance standpoint in under-burning.

Effect of Plaster—Properly applied gypsum plaster and cement plaster with lime substitutions of 50 per cent or less by volume, will stay in place throughout fire exposures up to the fusion point of the plaster.

Number of Cells—In the few cases where the shells were loosened the damage did not extend beyond the web adjacent to the shell so that with a larger number of cells there was a greater residual wall strength after fire exposure, damage being confined to the exposed surface of the wall.

Change of Design—Double side shell tile was developed, the outer shell being as thin as possible, the inner one serving to carry the load. Tests showed that the fire damage resulted in merely loosening the outer shell. Repairs could then be made by removing loosened shells and replastering.

Load Carrying Ability—The ability of tile walls to carry load under fire exposure is governed by the kind of clay used for the tile and the design of the units.

Deflection—The deflection of walls unrestrained at the top or vertical edges was away from the fire, being about 5 in. maximum at the top of an 8-in. wall and 3 in. at the top of 12-in. walls. In cooling, all of the test walls returned to within 2 in. of their original position. The deflection of restrained or loaded walls was toward the fire, being a maximum at the center of the wall. For 8-in. walls the movement at this point during the fire varied from $\frac{1}{2}$ to 2 in. and in cooling they returned to within less than $\frac{1}{2}$ in. from the original undeflected position. The amount of deflection decreased with increased wall thickness.

Brush Dam Built Annually on the Colorado Below Yuma

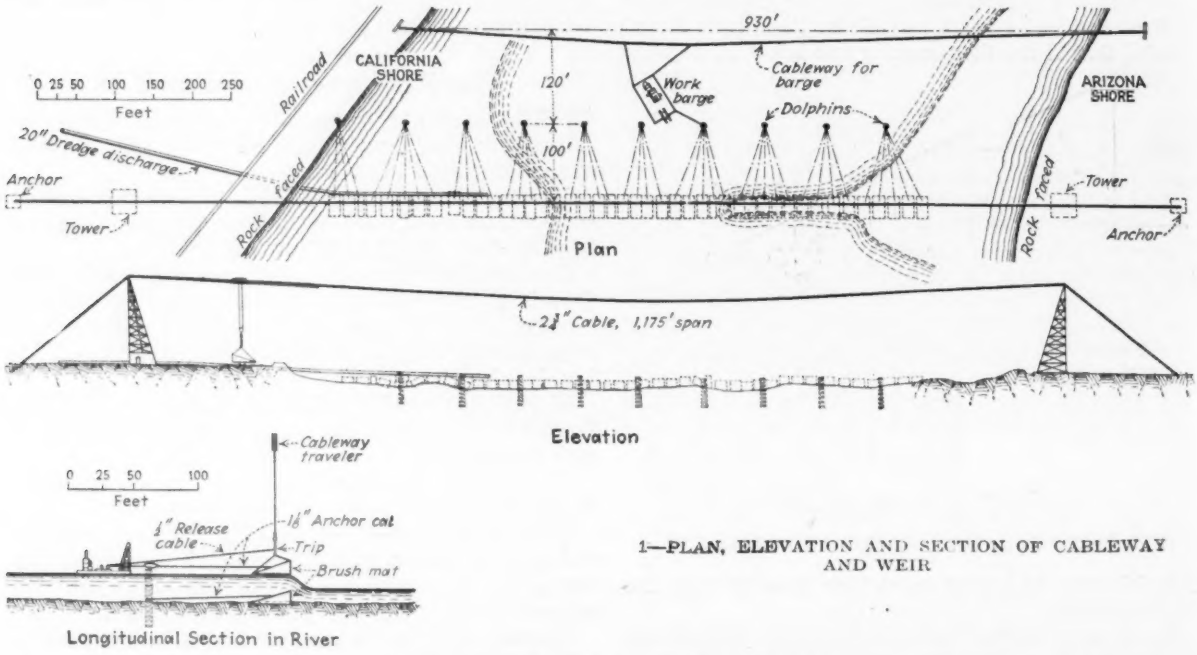
River Level Raised Temporarily by Wedge-Shaped Brush Bundles, Easily Built and Quickly Removed by Dynamite

AT the intake of the canal system for the Imperial Irrigation District in California, the surface of the Colorado River fluctuates from season to season over a range of 22 ft. For many years it has been the custom, as the low water period approaches, to decrease this range of surface level to about 14 ft. by building a temporary weir across the river 1,000 ft. downstream, thus insuring a continuous flow into the main canal during the low water season. The dam is purposely made of a light temporary character so it can be destroyed by dynamite on the approach of flood waters that would damage the Yuma district if the river were obstructed at this point in time of flood. In fact, the Imperial District annually posts a $500,000 bond to guarantee the safety of Yuma irrigationists from inundation due to this river obstruction.

At first these temporary weirs were made of pile trestle and rock fill at a cost of $100,000 to $125,000 per annum for construction; the complete destruction of such barriers was also rather expensive. In 1918, instead of the usual construction, a new plan was tried for making a weir of more temporary character. This was accomplished by building up a barrier of mats, as they are known locally, which consist of wedge-shaped bundles of arrow wood. The scheme has been improved from year to year as new methods have been devised and now the annual cost of the weir is only about $20,000 to $25,000 and the destruction cost is very much lower than formerly.

Warning of impending rises is given, of course, by telephone from gage stations farther up the river and because of the detached unit feature of the brush mat weir it is possible to dynamite out enough mats to release such part of the flow as is not needed to keep the river surface up to the desired level.

A permanent sill in the river at this point on which collapsible gates could be annually placed would be problematical and costly because in addition to the opposition of Yuma irrigationists to any such construction, there is also the difficulty that during high floods the river scours to a depth of 40 to 60 ft. below its normal bottom. There is no solid foundation even at that depth nor assurance that considerably deeper scouring might not occur. Hence there is the prospect that the brush dams will continue to be replaced annually to maintain suitable diversion levels during the low flood season.



1—PLAN, ELEVATION AND SECTION OF CABLEWAY AND WEIR

With this in view a permanent cableway across the river for handling the mats has been installed.

The river is about 950 ft. wide where the weir is put in and the cableway spans the stream at this point, Fig. 1, passing over towers on opposite sides of the river about 1,100 ft. apart. A row of pile dolphins about 100 ft. apart has been driven in the river, 120 to 150 ft. upstream from the cableway, to serve as temporary

FIG. 2—TYPICAL BRUSH MATS READY FOR DELIVERY TO CABLEWAY

anchorages for the mats while they are being settled in place and bedded down with silt.

The arrow wood used to build the mats grows in profusion along the levee railroad as a straight weed-like stalk. The brush is made into small bundles as it is cut and is brought in on the railroad to a storage yard near one end of the cableway where the bundles are built up

FIG. 3—CABLEWAY DELIVERING ONE OF THE MATS TO THE RIVER

into mats 25 to 30 ft. long, 14 ft. wide and 14 ft. thick at the thick end. They contain about 80 cu.yd. of brush and weigh about 7 tons each when ready to be placed in the river. The construction of the mats is indicated in Fig. 4. The bottom frame is put down first, brush bundles are placed on it in layers laid in opposite directions, and when built up to the desired shape and height the top frame is put on, tied down at the thin edge and then the brush is compressed by chain blocks, attached at the thick end of the wedge, that pull the two frames toward each other.

The mats are built up at odd times during the year when the men can be employed on this work to good advantage. When the annual flood period has passed and the flow has dropped to about 20,000 acre-ft. the

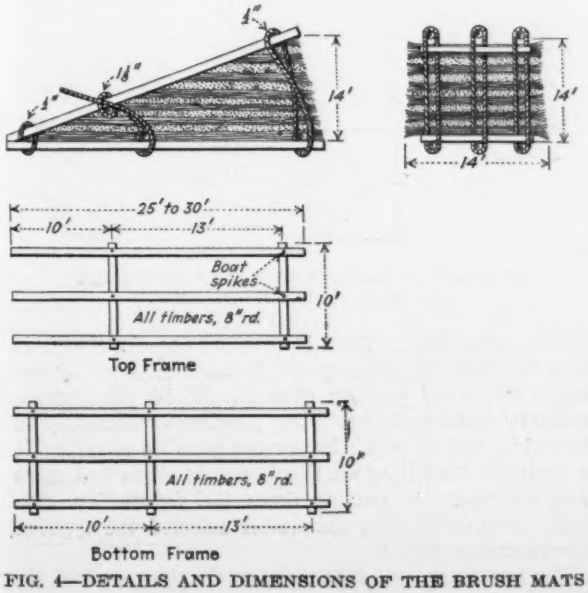


FIG. 4—DETAILS AND DIMENSIONS OF THE BRUSH MATS

mats are picked up by a locomotive crane and delivered to the cableway on the bank of the river. The process of getting the mats into the river has been so simplified that the entire row constituting the weir can be placed in a few hours by a crew of ten men. As picked up by the traveler on the cableway there are 3 lines to each mat; the line by which it is lifted; a 1¼-in. anchor line to tie the mat to the dolphin, and a ½-in. pull line that trips a release to drop the mat into the river at the desired point.

The end of the anchor line is looped so it can be passed over one of the pile dolphins when the mat is in position and this loop is thrust to the bottom of the stream before the mat is accurately located and the trip line pulled. The anchor cable being fastened on the inclined surface well toward the thin edge of the mat, the resultant of current and gravity forces that to act when the release is tripped, carries it quickly to the bottom.

After all the mats are in place, with brush bundles to choke up any spaces between adjacent mats, there is a considerable deposition of silt upstream from the dam due to the backing-up of the silt-laden waters. This is sometimes supplemented by the discharge of a dredge pipe from the nearby main canal and the result of a practically watertight brush and earth-fill dam has been accomplished.

For the foregoing data and illustrations *Engineering News-Record* is indebted to engineers of the Imperial Valley Irrigation District and to S. L. Rothery, consulting engineer, Los Angeles.

Concrete-Arch Highway Bridge to Be Tested to Destruction

AN EXTENSIVE series of load tests is to be carried out on a large concrete arch highway bridge in North Carolina during the coming summer and fall. About the end of the current year the bridge, crossing the Yadkin River near Swift Island, will be permanently submerged by the backwater of a power dam. The bridge is quite new, having been built only six years ago. Since the submergence will render it valueless, the state highway department and the U. S. Bureau of Public Roads have decided to utilize it as a test object, if possible carrying the tests to destruction. The tests will be planned with a view to giving better knowledge concerning the structural behavior of reinforced-concrete arches and girders.

The bridge comprises three open-spandrel arch spans of 146 ft. 3 in. clear, and a number of approach girders of 40-ft. clear span. The arch spans consist each of two ribs 4 ft. wide, 4 ft. 6 in. thick at springing and 2 ft. 6 in. at the crown. The roadway slab and fascia girder are independent of columns and floorbeams, being supported on them by means of steel bearing plates, which permit expansion; the slab is also cut at the piers, the crown and the quarter points by transverse expansion joints. The piers are relatively low and rigid, and rest on hard rock foundations practically at river bottom.

Plans for the test work have not been fully developed, but it is believed that they will include measurements of impact under heavy vehicle traffic, measurements of the elastic and inelastic deformation of the structure under load, and a failure test.

Five Missouri River Highway Bridges in South Dakota

State Builds Five Bridges in Three Years—Provision for Railroad—Piers Sunk by Dredging and Compressed Air—H-Beam Reinforcement—Pin and Riveted Truss Spans

By J. E. Kirkham
Bridge Engineer for South Dakota, Pierre, South Dakota

FIVE state highway bridges built across the Missouri River in three years is the record of South Dakota, a state which is but partially developed and has a population of only 685,000. The river flows south across the middle of the state, and until two years ago there were no highway bridges in this distance of 210 miles. Such a bridge was considered a big undertaking, likely to cost $1,000,000 and more. In 1921, the state legislature passed a bill levying a tax of 0.1 mill on all taxable property to provide for building bridges. In 1923, the fund thus created was large enough to interest localities along the river and five localities demanded that they be given the proposed bridge.

The Five Bridges—Analysis showed that five bridges were really required, as one bridge would do more harm than good in developing the state as a whole. Preliminary plans and estimates prepared by the writer showed that by rigid economy and taking advantage of local conditions at each site the five bridges could be built for a little less than $2,000,000. This expense the state could well afford as a development proposition.

In 1923, therefore, a bill was passed authorizing the construction of bridges at Wheeler (in the Rosebud country), Pierre, Chamberlain, Mobridge and Forest City. These locations have an approximately equal spacing and each is on a main trunk highway. An amendment to the bill permitted counties and municipalities interested in any bridge to advance 58 per cent of its cost, to be repaid by the state when sufficient money had accumulated in the bridge fund. The remaining 42 per cent could be supplied from federal-aid funds. As a result, the Mobridge, Chamberlain and Forest City bridges were built by using federal aid, while the Wheeler and Pierre bridges were built by the use of the state fund only.

The Mobridge bridge was opened to traffic Nov. 12, 1924; the Wheeler bridge, Sept. 1, 1925; the Chamberlain bridge, Sept. 22, 1925, and the Pierre bridge, June 26, 1926. The Forest City bridge is expected to be opened in May, a part of the concrete floor and the painting of the steel having been stopped by cold weather. The bridge was practically finished by December, 1926. Thus the entire program was completed in three years at a total cost of about $1,900,000. The Wheeler Bridge, Fig. 2, is in general typical of these five bridges.

Foundation Conditions—For practically its entire course across South Dakota, the Missouri River runs over a stratum of shale rock from 800 to 1,300 ft. thick, generally known as Pierre shale, although it varies in composition from shale at Mobridge to practically a chalk rock at Chamberlain and Wheeler. It scours very slowly, perhaps ¼ in. in a year, and is of sufficient hardness to support from 40 to over 100 tons per square foot before yielding. It can be excavated easily, especially by the use of steam and pneumatic hammers. Steel piling can be driven to a depth of 5 or 6 ft. without shattering the rock, and it is practically impossible to pull the piles. One contractor tried to pull an H-beam which had been driven only about 4 ft. and was out of line, but two 50-ton jacks acting under full pressure failed to even start the pile.

Substructure for Wheeler Bridge—The foundations and substructure design of the bridge at Wheeler, Fig. 1, are typical of all the bridges, except as to certain

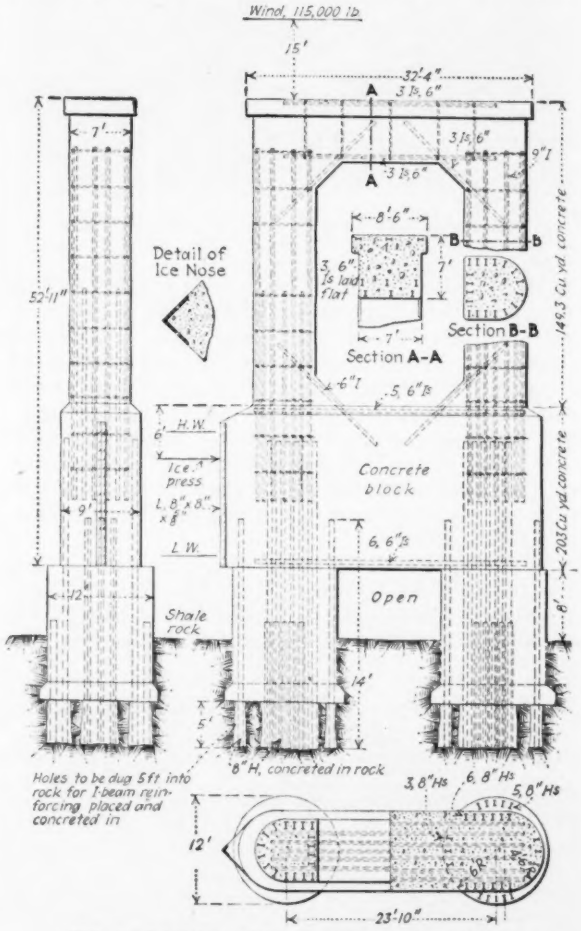


FIG. 1—TYPICAL PIER OF WHEELER BRIDGE
Note heavy H-beam reinforcement.

details noted later. At this crossing the shale rock is bare for half the distance and is made slippery by the water and sand passing over it. Wood piling with ordinary metal points will not penetrate sufficiently to be stable, and in order to prevent possible scouring it is desirable that the rock should not be disturbed more than necessary in putting down the foundation. To meet these conditions, the writer selected the type of pier shown in Fig. 1.

The two 12-ft. cylinders were set in place, and where there was no overlying sand and gravel they were held

temporarily with an H-beam pile driven a short distance into the shale. Then a circle of sheetpiling was driven around each cylinder about 3 ft. from the cylinder, with a penetration of 12 to 18 in., a puddle wall being placed between the cylinder and the piling. The water was then pumped out of the cylinder and the shale was excavated 6 to 8 ft. by the use of jack-hammers and picks; holes were dug for the steel piling, which was then placed and concreted in.

After the cylinders had been filled with concrete up to the level of the bottom of the concrete block which connects them above water, the sheetpiling of the downstream half of the upstream circle and the upstream half of the downstream circle was pulled and then driven along the sides of the pier, forming one large cofferdam with semicircular ends. This cofferdam was filled with sand and earth up to the level of the bottom of the concrete block and the water was then pumped down to that level. The forms were then placed for the block, the remainder of the reinforcing steel was placed and the concrete in the block was poured. It should be noted that in handling the work in this manner the minimum amount of pumping is required, which is quite an item of cost.

Pier Design—The pier, as a whole, is considered as a rigid frame fixed at the bottom into the rock. This undoubtedly is true so long as the stress on the bottom of the footings is not reversed by cross-bending and surely fixed if the piling be considered. Although the lateral resistance from the shale rock offers sufficient resistance to fix the cylinders, this resistance was not considered in designing these piers. However, there is no question but that it exists, as the contractor was caught with just one cylinder concreted on pier 2 when the ice went out. This one cylinder took the entire heavy flow of the ice, acting as a post. The H-beams

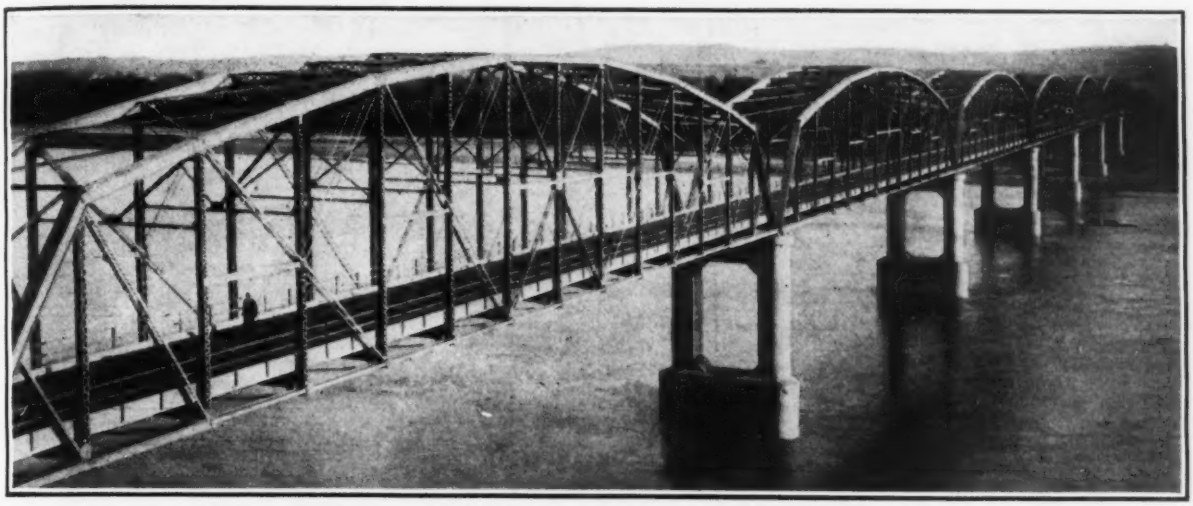


FIG. 2—MISSOURI RIVER HIGHWAY BRIDGE AT WHEELER, SOUTH DAKOTA
This bridge is typical of five built by the state. At Wheeler, six spans of 256 ft.; at Pierre, six of 336 ft. and 300 ft.; at Chamberlain, four of 336 ft.; at Mobridge, five of 256 ft.; at Forest City, four of 256 ft. and two of 300 ft.

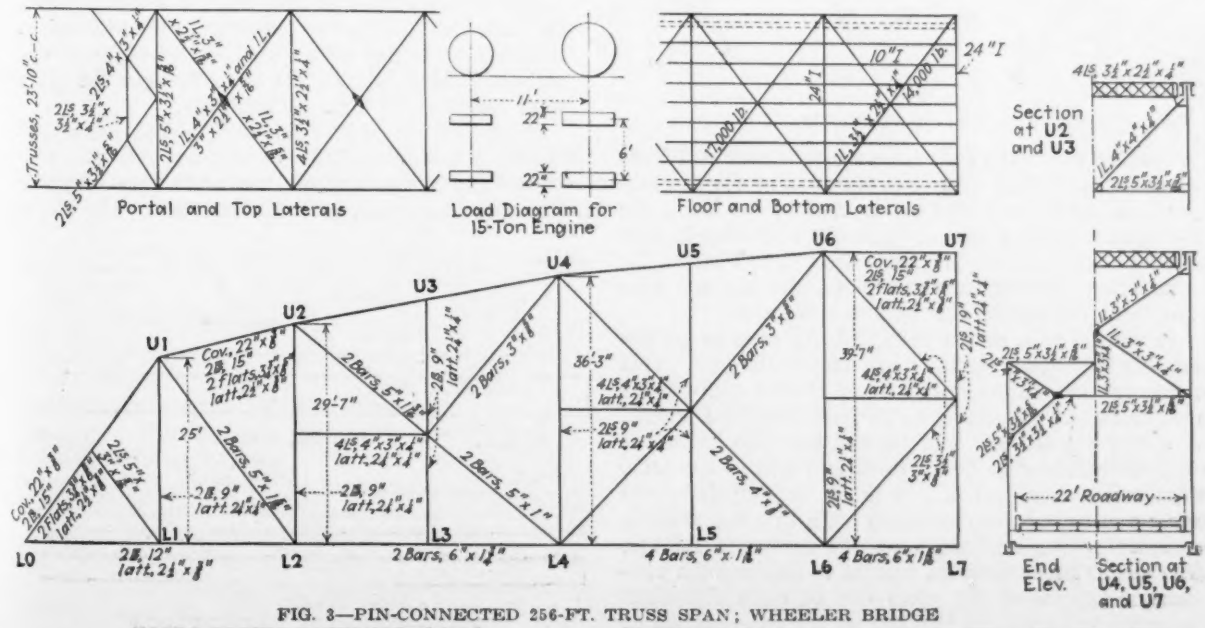


FIG. 3—PIN-CONNECTED 256-FT. TRUSS SPAN; WHEELER BRIDGE

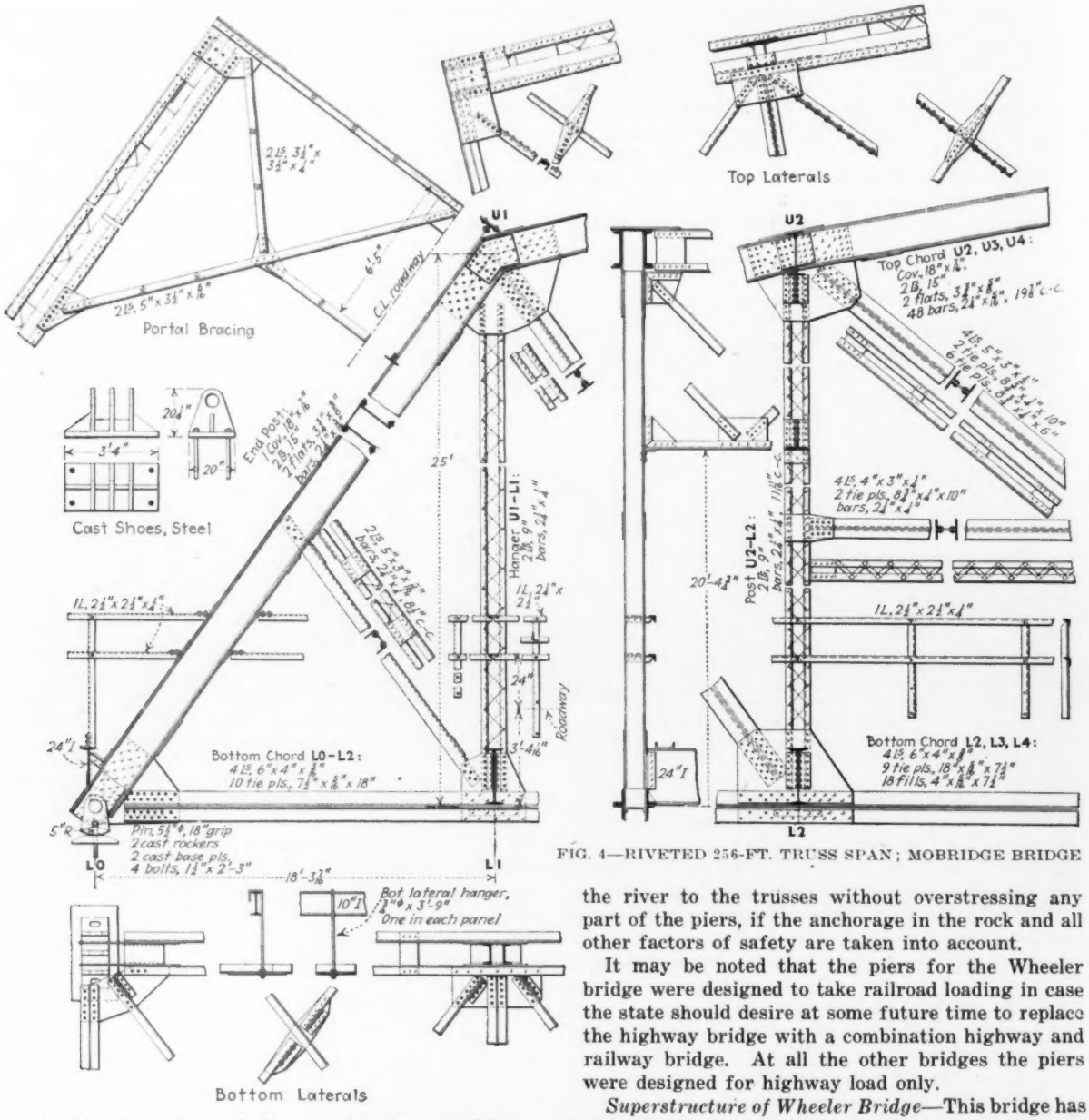


FIG. 4—RIVETED 256-FT. TRUSS SPAN; MOBRIDGE BRIDGE

projecting above the cylinder were bent over and hammered against each other, yet the footing (to the surprise of the writer) was not injured in the least. So no doubt the post action of these 12-ft. columns is very much a factor of safety. As to the use of I-beams for reinforcing throughout those piers, the writer's idea was to obtain stiffness as well as strength.

It will be seen that a vertical blunt nose as an ice-breaker is used for the upstream face of the pier. This form was adopted as the result of careful study of ice conditions and ice action, which study will be discussed in a separate article. The piers of the Wheeler bridge will cut through ice 20 ft. thick and will at the same time resist a cyclone of 100 m.p.h. coming down the river and acting simultaneously with this ice, without considering the anchorage on the upstream footing. The writer never took the trouble to compute the ultimate resistance of the piers due to some ridiculous pressure, but ice could be piled up from the bottom of the river to the trusses without overstressing any part of the piers, if the anchorage in the rock and all other factors of safety are taken into account.

It may be noted that the piers for the Wheeler bridge were designed to take railroad loading in case the state should desire at some future time to replace the highway bridge with a combination highway and railway bridge. At all the other bridges the piers were designed for highway load only.

Superstructure of Wheeler Bridge—This bridge has six 256-ft. pin-connected through-truss spans, with concrete floor, 22-ft. roadway, and two 64-ft. through plate-girder approach spans, with similar floor. The stress

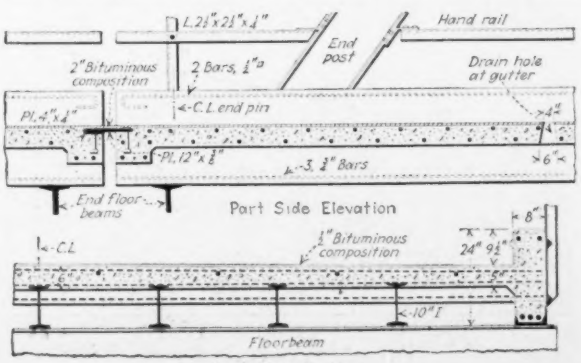


FIG. 5—CONCRETE BRIDGE FLOOR

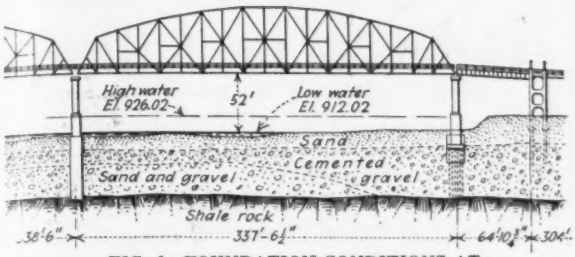


FIG. 6—FOUNDATION CONDITIONS AT CHAMBERLAIN BRIDGE

sheet for the truss spans is shown in Fig. 3, with the loading and weights. The live-load of 80 lb. per square foot is equivalent to two lines of 15-ton engines or motor trucks spaced 35 ft. Dead-load was assumed as 1,300 lb. per foot of span for the steelwork and 2,000 lb. for the floor. The weight of one span complete is about 341,700 lb.

Details of the floor and handrail connections are given in Fig. 5. The outside joist is a concrete beam which acts as a felloe-guard and joist. The railing is connected directly to the outside (concrete) joist, and the intermediate (steel) joists are supported directly upon steel shims resting upon the floorbeams to prevent concentration on outer edge of floorbeam flange. A ½-in. bituminous coating as a wearing surface was specified, as the writer considered this thin coating, which is easy to repair, preferable to a thicker pavement which would necessitate importing expert pavement workers when repairs were needed. It appears that this thin coating of bituminous composition and granite chips is going to be satisfactory. Its first cost is low and the maintenance cost also is likely to be low. The Kansas City Bridge Co. had the general contract for the Wheeler bridge at $370,000. The steelwork was fabricated by the American Bridge Co.

Mobridge Bridge—At Mobridge the crossing is quite similar to that at Wheeler. The piers with 11-ft. cylinders were intended only for a highway structure, but the same ice and wind loads were considered as in the case of the Wheeler bridge. Here the steel anchor piles were driven into the shale instead of digging holes and concreting them as at the Wheeler bridge. Steel H-beam piles were driven 5 to 6 ft. without shattering the rock, as this is pure tough Pierre shale. The cylinders are set 8 ft. into the rock, the lower 4½ ft. being belled out to a diameter of 15 ft.

The superstructure consists of five 256-ft. riveted through-truss spans and three 64-ft. through plate-girder spans, all with floors as in the Wheeler bridge. The riveted truss design is shown in Fig. 4. The entire bridge, including foundations, was built by the Minneapolis Bridge Co. in about ten months, at a cost of $328,000. Steel was fabricated by the American Bridge Co.

Chamberlain Bridge—At this crossing the rock was more of a chalk rock than shale, but it was quite hard and firm. As shown by Fig. 6, this rock was overlaid by 15 to 30 ft. of cemented gravel, which was so firm as to require picks in excavating. The piers were sunk by the use of compressed air, the two cylinders in each pier being sunk simultaneously. They are set 18 in. into the rock.

Four 336-ft. riveted through truss spans, with floor as in the Wheeler bridge, form the main superstructure, as shown by Fig. 7. The west approach consists of a 64-ft. through plate-girder span and 305 ft. of reinforced-concrete viaduct. The east approach has only a 64-ft. through plate-girder span. This bridge was fabricated and built throughout by the Missouri Valley Bridge & Iron Works, Leavenworth, Kan., at a cost of $377,000. The concrete viaduct approach was added after the bridge proper was practically completed and cost about $33,000.

FIG. 7—MISSOURI RIVER BRIDGE AT CHAMBERLAIN, SOUTH DAKOTA
Four riveted truss spans of 336 ft.

Pierre Bridge—At the Pierre crossing, which has six spans, there is an upper stratum of cemented sand and gravel, varying from heavy gravel and boulders to black coarse sand. It is evident from the fossils found that there will be no trouble from scour. The underlying rock is Pierre shale. The two cylinders in each pier were sunk simultaneously and by the use of compressed air. They are set 8 ft. deep in the rock, and at the base a cross-shaped trench was cut, each arm projecting 2 ft. beyond the cylinder and having five 12-in. I-beams embedded in concrete to serve as anchorage. The Missouri Valley Bridge & Iron Works built the five channel piers in two months and 28 days, which the writer considers a record.

The superstructure consists of six through-truss riveted spans, four of 300-ft. and two of 336-ft., all with the concrete floor already described. Eacn approach consists of a 90-ft. concrete viaduct. The steel superstructure was fabricated and erected by the Lakeside Bridge & Steel Co., North Milwaukee, Wis. This bridge is 2,072 ft. long and the average depth of the channel piers is about 56 ft. below mean low water. The completed structure cost about $440,000.

Forest City Bridge—The river bed profile here is similar to that at the Wheeler and Mobridge crossings and the substructure is similar. The superstructure consists of four 256-ft. riveted spans (which are the same as those of the Mobridge bridge), and two 300-ft. spans, the same as those for the Pierre bridge. Each approach consists of a 64-ft. plate girder span. The contract was awarded to the St. Louis Structural Steel Co., St. Louis, Mo., at about $329,000. This company fabricated the metal work and delivered it to the nearest railroad point, but sublet all of the construction to R. L. Gaster & Co., Little Rock, Arkansas.

Design Miscellanies—In the Wheeler bridge, pin-connected trusses were used with the idea of cheapening the cost of taking them down in case the state, at some future time, should decide to replace the superstructure with a combination railroad and highway superstructure. At Mobridge and Forest City, the same lengths of span were used as at Wheeler but the spans were riveted trusses. It has been interesting to observe the action of these two types of spans. Opinions differ. Some claim that riveted spans are more rigid than pin-connected spans. The writer has been unable to observe any difference in rigidity of the two types of spans.

Open-hearth steel is used throughout, with the exception of rivet steel for the rivets. Wind load was taken as 300 lb. per foot on the bottom chord and 150 lb. on the top chord. End bearings in all the bridges consist of 5½-in. pins through the webs of the end posts and cast steel shoes. At the expansion end, Fig. 4, the shoe has a cast steel rocker plate of 5-in. radius seated on a base plate.

Chicago Plans Industrial Museum

Following an inspection of foreign industrial museums the Chicago South Park Commissioners are planning an industrial museum to be established in Jackson Park. Its nucleus will be the Fine Arts Building, erected for the Columbian Exhibition of 1893, which has a floor space of 305,925 sq.ft. For the restoration of this building a bond issue of $5,000,000 has been approved, while $3,000,000 has been offered by Julius Rosenwald to assist in establishing the industrial museum. The bond issue provides for a great convention hall, industrial museum, school of industrial arts, museum of architecture and sculpture, women's memorial hall, and athletic, art and social centers. In a recent address before the Chicago Association of Commerce, E. J. Kelly, president of the South Park Commissioners, stated that before taking action as to plans for the building it is proposed to consult with civic organizations and others interested. Then official steps will be taken as to the design of the buildings to be erected, the order of erection, and the distribution of space.

Letters to the Editor

A Forum for Discussion of Views of Engineers and Contractors

Canadian Housing and Land Development Planning for Economy

Sir—I inclose a monograph on "Housing in Relation to Land Development" which I prepared for the Social Service Council of Canada. I think a perusal will show that it has a great deal to do with problems of municipal development with which engineers are vitally concerned, and I am constantly trying to show that engineers have a mission to perform in planning for settlement of population, both urban and rural.

On pp. 24 and 25 will be found some figures showing the cost of high-class residential districts in the Vancouver area in the province of British Columbia in the periods both before and after the War. As they were planned for a specific purpose, speculation is largely eliminated. On the other hand, with the ordinary type of city development occupied by working people, the assessed value of the land when annexed to the city, without any improvements, was more than that of high-class residential land with all improvements, and at the present time is twice the value, according to municipal assessment. Why cannot engineers plan for sites for working people as well as for the wealthy?

A. G. DALZELL.

Toronto, Ont.,
April 20, 1927.

[One reason why engineers do not plan sites for working people, or do not plan more of them, is because they are seldom given a chance to do so. As Mr. Dalzell emphasizes in his interesting monograph, building sites are not planned for use but for sale. He cites fact and opinion indicating uneconomical land development throughout Canada, largely because hundreds of acres are subdivided long before they are needed for residences and for years only scatteringly built upon. This results in high costs for streets, water, sewer, lights and other services or going without some or all of these. In many cases, the lots are far too small for decent and healthful houses, due to greed and to a real estate maxim that the lots should be of a size ultimately suited to business purposes. Poor housing conditions in rural as well as urban areas, and slums of a sort in new Canadian cities with all outdoors to build on are described. Stress is laid on the fact that housing costs are way above the means of the wage earners generally. The monograph contains little by way of proposed remedies beyond more and better city and rural planning which would undoubtedly be of great assistance. The monograph may be obtained (25c.) from the Social Service Council of Canada, Metropolitan Building, Toronto 2, Ontario.—EDITOR.]

Curbing the Speaker

Sir—Time limits can be enforced in conventions, even by the "stop and go" signal system described in your editorial "Time Limits for Speakers," March 31, 1927, p. 512. I have seen it done but not by hard-boiled chairmen. The colored light on the speaker's or reader's desk is right. The chairman, with the consent of the convention, makes the rule as to time allowed but the lights are controlled by a timekeeper who is not known and not visible.

The warning light flashes and the chairman has nothing to do with it but may call attention to it. The red light is a signal for applause by the audience or a motion from the floor that the speaker be granted so many minutes more time.

The timekeeper again flashes the lights at the end of the time extended, if any, and the agony is over.

C. R. HENDERSON,
Davenport Water Co.

Davenport, Iowa,
April 2, 1927.

News of the Week

Current Events in the Civil Engineering and Contracting Fields

Mississippi Flood Crest Passing Vicksburg

West Bank Bearing Brunt of Flood—Arkansas and Louisiana Inundated—Official Break Made Below New Orleans

THE great flood in the Mississippi is passing down the river at stages about as predicted. There have been several breaks on the west bank levees which have added to the inundation of the Arkansas and Louisiana basins. No break has occurred on the east bank levees since the major break at Stopps Landing on April 21. Continually increasing areas of the valleys of the Tensas, Ouachita and Red Rivers have been inundated as the flood water from the upper breaks moves south. The entire west levee system is backed by flood water from the high ground at Helena to the mouth of the Red River. On Apr. 29 the major levee on the east bank below New Orleans was officially breached, as described in the accompanying article by Mr. McWhorter, and the situation around New Orleans is explained in his article.

The accompanying map gives the known inundated areas in the valley on May 4. It is an extension of the map given in the issue of Apr. 28, p. 704. According to reports from the army officers in charge of the river, the major breaks in the Mississippi levee have been as in the following table. The ones at Milliken Bend, Glasscock and Bougere have occurred since the report of last week.

MAJOR BREAKS IN MISSISSIPPI LEVEES

	Mi. below Cairo	
Dorena	33	Apr. 16
Walnut Bend	278	Apr. 15
Knowlton	366	Apr. 20
Laconia	376	
Stopps Landing	435	Apr. 21
Milliken Bend	580	May 3
Glasscock (2)	700	Apr. 30
Bougere (2)	710	May 1
Junior	1,000	Apr. 23

In the table on p. 743 is given the gage record in the lower river. This should be read in connection with the record given in the report in these columns last week.

The following telegrams have been received from the United States Army Engineers in charge of the three districts of the Mississippi River Commission. Each telegram is dated May 3.

From Major D. H. Connolly, Corps of Engineers, at Memphis:

> "Am glad to advise that present flood has about expended its force in this locality. The first and second Mississippi River Commission districts extend from Cape Girardeau, Mo., to the mouth of the White River, Ark., a distance of about 450 mi. The flood is now receding very satisfactorily throughout the district. At Cairo, 55 mi. below the upper end of district, there has been a fall of 8½ ft., and at that point the river will drop below flood stage by about May 6. At Memphis about midway of the districts, there has been a fall of 3.3 ft. where it is expected to pass below flood stage by May 14. At Helena, about 130 mi. above lower end of districts, there has been a drop of 2.7 ft., and at that point it is expected to pass below flood stage by May 20. When the flood has passed below the so-called 'flood stage' at the several stations mentioned, areas overflowed from crevasses or back waters will be practically unwatered. None of the crevasses in the districts occurred in levees that had been completed to standard Mississippi River Commission section and all of them except Dorena crevasse broke through into territory already overflowed by back water flowing around end of levee system, the Laconia and Walnut Bend crevasses being within 8 miles and Knowlton crevasse within 15 mi. of ends of their respective systems.
>
> "The upper St. Francis levee district, 87 mi. in length, had no breaks in upper 63 mi. of the system. The Reelfoot levee district, 21 mi. in length, had no breaks whatever. The lower St. Francis levee district, 218 mi. in length, had no breaks in the upper 207 mi. The White River levee district, 67 mi. in length, had no breaks in upper 52 mi. The upper Yazoo levee district, 100 mi. in length, had no breaks whatsoever."

From Major J. C. H. Lee, Corps of Engineers, at Vicksburg:

> "The U. S. gage at Vicksburg at 1 p.m., May 3, read 58.6 ft. The previous highest stage recorded was 54.8 in 1922. The established provisional grade line to which all levees in vicinity of Vicksburg have been built is 58 ft. The water was 0.6 above the established grade of the levees. At 1:30 p.m. today the levee broke at Cabin Teele, La. (Milliken Bend), fifteen mi. above Vicksburg, caused by low levee on uncompleted levee contract which had been topped with sacks 6 ft. high and with 4½ ft. of water against sack topping. The levee and topping failed bodily by sliding or overturning. This crevasse will completely overflow Madison and Tensas parishes in Louisiana. The river will be lowered at Vicksburg 2 or 3 ft. in the next two days. Pressure will be relieved on all other levees Vicksburg to mouth of Red River. Below mouth of Red River water will all return to either the Mississippi or Atchalalaya, causing even higher flood heights than originally anticipated."

From Maj. W. H. Holcombe, Corps of Engineers, at New Orleans:

Welding Society Discusses Developments of Art

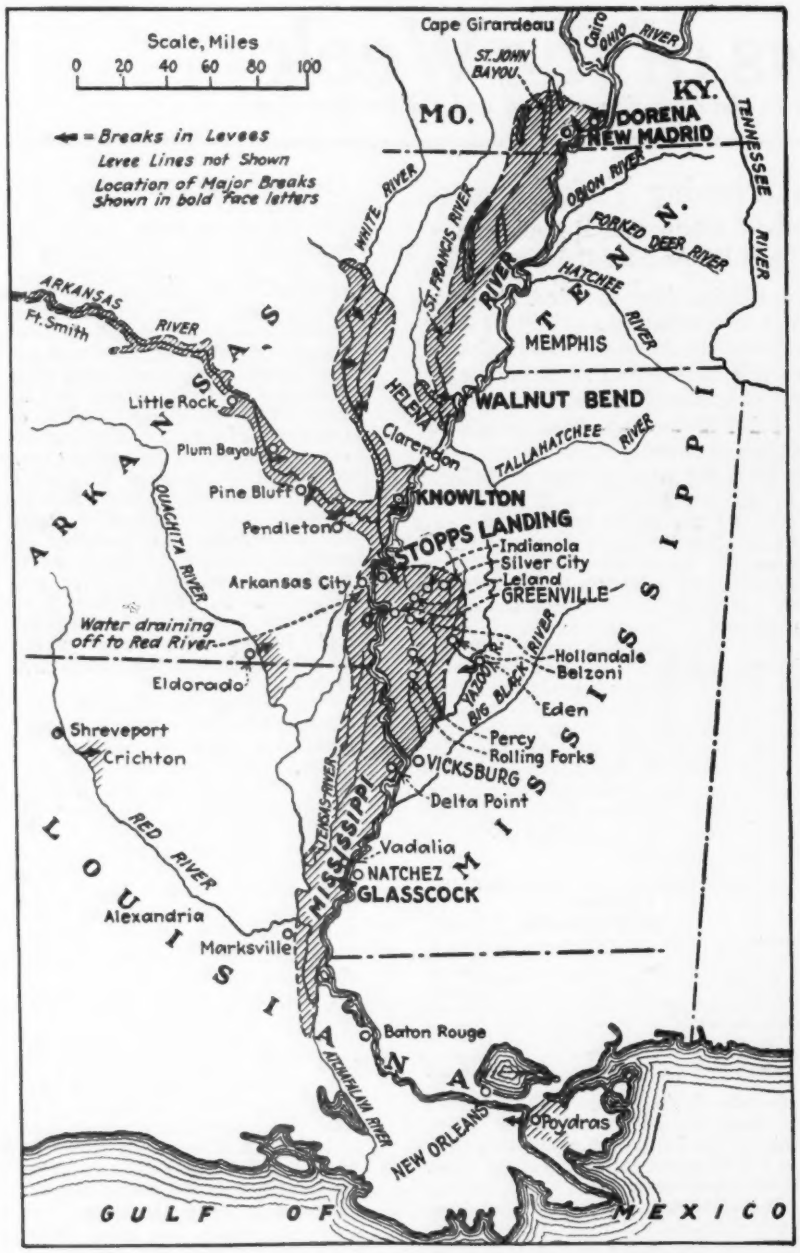
Research Activities and Production Progress High Points at N. Y. Sessions

A number of technical and descriptive papers of interest were presented last week at the annual meeting of the American Welding Society at New York. The principal technical proceedings were grouped in the two sessions of Thursday, April 28, the first of which was devoted to a review of recent research activities and the second to developments in production.

In the review of research, the most generally interesting reports were those of R. R. Moore, of the Army Air Service, on "Fatigue of Welds," and J. W. Owens, of the Newport News Shipbuilding & Dry Dock Co., on welding research activities at that plant. Mr. Owens described a considerable number of separate questions that were investigated in the course of commercial production work during the year. It was determined by tests that galvanized sheet steel from No. 24 to No. 11 gage can be butt welded satisfactorily, provided the die points are rounded and twice the current and half the pressure used for black metals be applied. In tests to determine the influence of welding on paint between the contact surfaces it was found that the paint is no more extensively destroyed by welding than by riveting. Iron oxide paint seems to be preferable to red lead for painting the contact surfaces because less of the paint is destroyed and the welds have fewer blowholes. In another series of experiments it was determined that a seam which is being welded progressively draws the contact surfaces together, so that it is not necessary to assemble them as tightly as required for riveted joints.

Mr. Moore's paper cited the results of an extended series of fatigue tests on ¾-in. and 1-in. tubes butt welded at mid-length, some with gas flame, some with the metal arc, and some with the atomic-hydrogen welding process. The three processes gave roughly similar results, with endurance limits generally ranging from 13,000 to 22,000 lb. per

(Continued on p. 745)



MAJOR LEVEE BREAKS AND FLOODING ON LOWER MISSISSIPPI

Since this map was made two major breaks have occurred on west bank levees at Milliken Bend, 15 miles above Vicksburg and at Bougere, about 10 miles below Glasscock.

"Fourth Mississippi River district extends from Warrenton about 7 mi. south of Vicksburg to mouth of Mississippi. Conditions quite critical at several places on Louisiana side from north boundary of district to and below Vidalia. Kempe Bend reported very critical. Two crevasses occurred Apr. 30 at Glasscock, 28 miles by river below Vidalia, and two on May 1 at Bougere, about ten river miles farther down stream. This crevasse water will raise back water levels in lower Tensas district and will return to Mississippi and Atchafalaya via old river. West bank levees below old river in excellent condition and it is hoped and expected that they will withstand the flood. Hill country and no levees on east side Vicksburg to Baton Rouge. East bank levees below Baton Rouge in excellent condition and expect them to hold up well throughout flood. Relief from artificial crevasse at Caernarvon on East bank 14 miles below New Orleans already being felt. This together with Point A La Hache spillway and crevasse caused by tankship 'Inspector' on Apr. 23

(Continued on p. 745)

Breaching the Levee Below New Orleans

Details of the Caernarvon Break Ordered by the Governor of Louisiana to Relieve New Orleans

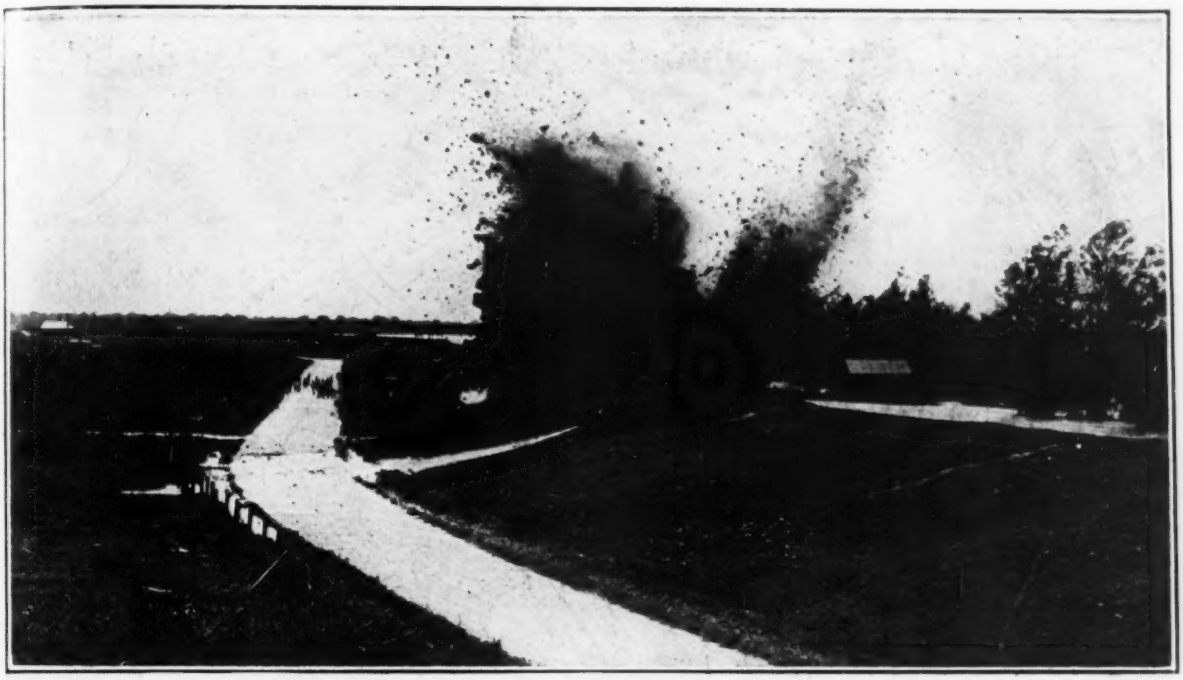
By Roger B. McWhorter
Special Engineer, Orleans Levee District, New Orleans, La.

Work was begun April 29 on the removal of approximately 1,500 ft. of the main levee on the east bank of the Mississippi River at and immediately below the point where the boundary line between St. Bernard and Plaquemines parishes, Louisiana, strikes the river, to create a crevasse to reduce the height of the impending flood in the lower river and especially at and for a few miles above New Orleans. The break is 22 miles downstream from the Carrollton gage and 13½ miles downstream from the foot of Canal St., New Orleans. It is about 4,000 ft. downstream from the site of the Poydras crevasse of the flood of 1922 and opposite the settlement of Caernarvon, by which name the crevasse is now known.

The levee at the site of the crevasse has a top width of 10 ft., with a slope on the river side of 3:1 and on the land side of 4:1. Its top is at El. 19.6 (mean Gulf level, as are all elevations herein given). The elevation of the ground on the land side is approximately 5 ft., the levee being about 14½ ft. high. The levee is 350 ft. from the river and the elevation of the batture between the river and levee is 9½ ft. When work was begun the elevation of the river surface at that point was 16½ ft., making a depth of about 7½ ft. on the batture; the freeboard was slightly more than 3 ft.

The idea is to create a crevasse that will divert 240,000 sec.-ft., or sufficient to effect a local lowering of 3 ft. which will result in a lowering of the flood gage along the New Orleans waterfront of from 2 to 2½ ft. Material lowering is also expected along the levee above the city, but it is believed that the effect at Baton Rouge will be too slight to be of practical value. Dynamite is being used to burst down the levee and the gap will be completed by May 3.

There was no immediate effect following the first blasts nor was any expected or desired. The river has been stationary at the Carrollton gage since the work was begun, but as all upstream gages as far as Vicksburg show rises it is certain that the discharge at Carrollton is being gradually increased without corresponding increase to stage. The Caernarvon crevasse is now, Sunday forenoon, about 800 ft. wide and is scouring rapidly. The results obtained thus far are exactly as desired. The Carrollton gage reads 20.8 and thorough preparation has been made in New Orleans to provide for higher stages. Forecasts of the Weather Bureau are to the effect that levees will be overtopped at practically all stations on the lower river if the levees hold. The forecast for Carrollton is for a maximum stage of 24 ft. and it is the expectation and intention to make the Caernarvon crevasse of such



THE SECOND BLAST AT CAERNARVON CREVASSE BELOW NEW ORLEANS

capacity as to hold the Carrollton gage below 22 ft.

The batture in front of the crevasse is being progressively eroded and will doubtless be scoured down to or below the surface elevation of the ground back of the levee. No difficulty is expected in making the crevasse take the required amount of water as it can be given any required length. The gage readings for May 1 at 7 a.m., just received, are: Vicksburg, 57.8, up 0.6 ft.; Baton Rouge, 45.8, up 0.4 ft.; Plaquemines, 41.1, up 0.3 ft.; Donaldsonville, 35.9 up 0.2 ft.; and Carrollton, 20.7, down 0.1 ft., showing results expected and desired. The river is rising at the several stations above Carrollton while a fall of 0.1 ft. is recorded at Carrollton.

The Caernarvon crevasse is being opened pursuant to an order of the governor of Louisiana under date of April 26, following an opinion of the attorney-general of Louisiana supported by the views of several prominent lawyers of New Orleans that such a course would come within the purview of the state's police power. This authority is aptly termed as "more in point than statutory." There is no precedent for such action in the history of the Mississippi River levees. The governor had been advised by the business interests and by the leading engineers of New Orleans of the desirability of creating an outlet to reduce river stages over the crest of this flood.

Permission of the Mississippi River Commission was requested and that useful body not only recommended approval to the Secretary of War and the Chief of Engineers but expressed the opinion that more destructive crevasses were imminent and might be avoided by the creation of a crevasse in the predetermined location. The Secretary of War and the Chief of Engineers interposed no objection to a temporary break on the understanding that the federal government should in no wise be held responsible for damages incurred. Damages have been assumed by the state of Louisiana and the city of New Orleans through constituted authorities and the full faith of the state and city is behind that assurance.

There were several conclusive reasons for lowering the crevasse at Caernarvon: (1), unimportant interruption to transportation (there is only one railroad on the east bank at this site and that a relatively unimportant one, and there is but one highway); (2), damages will be far less at this site than would have been incurred at any other site; (3), effective relief is obtainable by a break at this site; and (4), proximity to tidewater. The habitable and agricultural lands in St. Bernard Parish and that part of Plaquemines Parish east of the Mississippi River consist of a strip of high ground about 3,000 ft. wide along the river bank. The balance of the area consists of sea marsh, the elevation of which is from 1 ft. to 1½ ft. above mean Gulf level. The parishes are sparsely populated and the principal industry aside from truck gardening is muskrat trapping. A large percentage of all pelts furnished to the fur trade in the United States comes from the marsh lands of these two parishes. There is difference of opinion as to the effect that the crevasse will have on muskrats. Based on the experience of the Poydras crevasse the trapping business will probably be adversely affected during the first year following the crevasse, but greatly improved thereafter.

The governor's proclamation allowed only three days for the evacuation of the parishes but it was not necessary to evacuate the lower end of Plaquemines Parish as that area is protected by levees. The evacuation started several hours before the proclamation was issued, based on more or less authentic rumor. Some of the official messages had been transmitted by radio.

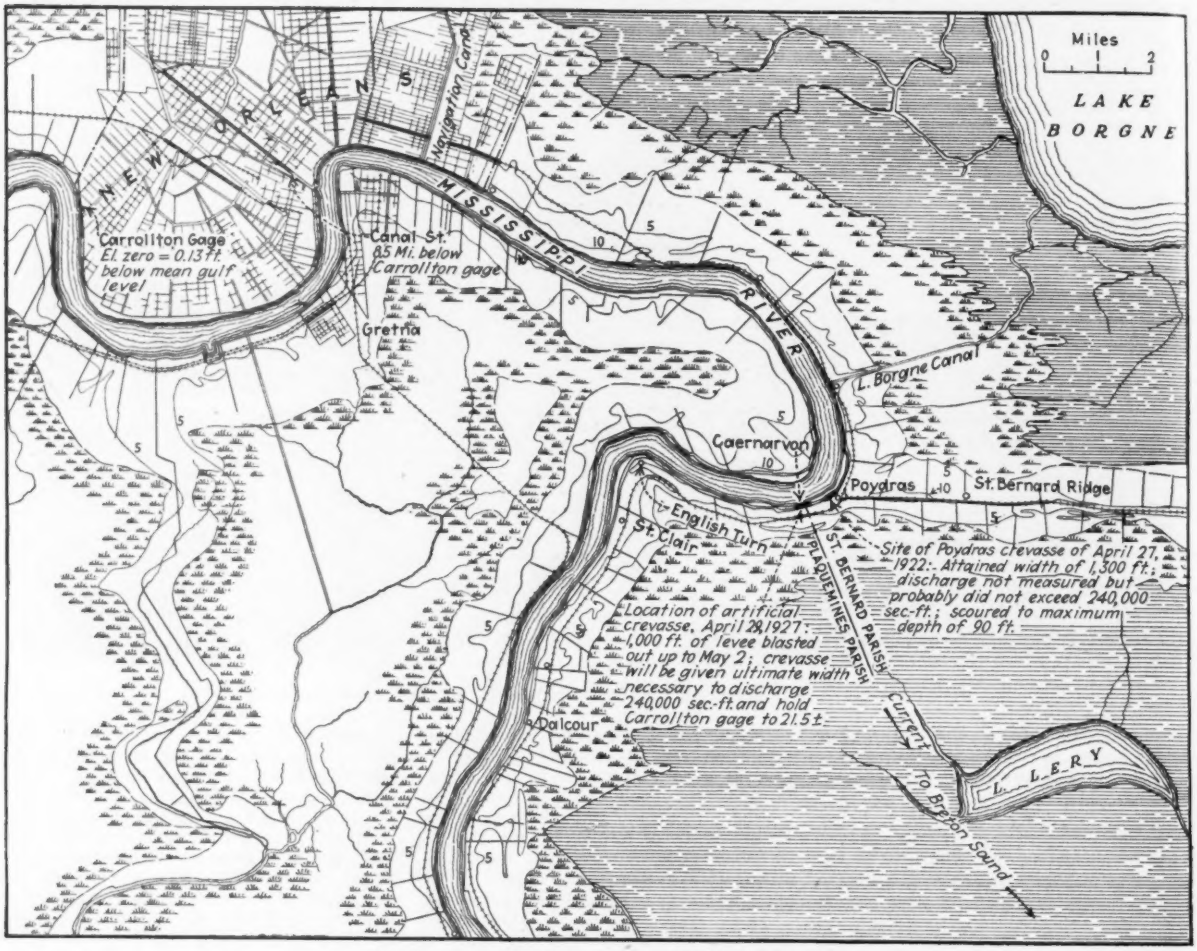
The execution of the governor's order was committed to the chief of the board of state engineers, George C. Schoen-

GAGE HEIGHTS AT MISSISSIPPI VALLEY POINTS

	Mississippi River						Red River	
	St. Louis	Memphis	Vicksburg	Natchez	Baton Rouge	New Orleans	Shreveport	Alexandria
Flood Stage	30.0	35.0	45.0	....	....	17.0	29.0	....
*Provisional Levee Grade	....	51.5	58.0	57.5	48.1	25.2	....	....
1922	34.0	42.5	54.8	55.3	45.7	21.3	....	....
Previous High	41.4	46.5	53.8	53.5	43.8	21.1	....	....
1927								
April 24	35.6	45.9	54.8	55.3	44.8	20.8	34.1	....
April 25	35.8	45.9	54.5	55.2	45.0	21.0	35.1	38.0
April 26	36.1	45.6	54.4	55.0	45.0	20.9	36.0	38.3
April 27	35.6	45.4	54.9	55.0	45.0	20.8	36.7	38.7
April 28	34.6	45.1	55.7	55.1	45.0	20.8	37.2	39.0
April 29	33.4	44.7	56.3	55.5	45.1	20.8	37.4	39.5
April 30	....	44.3	57.2	56.1	45.4	20.8	37.4	40.0
May 1	....	43.8	57.9	56.5	45.8	20.7	36.9	40.5
May 2	....	43.2	58.2	56.4	45.7	20.7	36.4	40.1
May 3	....	42.7	58.5	56.4	45.4	20.4	35.4	41 3

* Provisional Levee Grade adopted by the Mississippi River Commission in 1914 as the required height of levee crest measured on the local gages. Elevation of the gage zeros, referred to mean Gulf levels are as follows: Memphis, 184.21; Vicksburg, 46.16; Natchez, 17.09; Baton Rouge, —0.42; Donaldsonville, —1.25 and New Orleans (Carrollton gage) —0.13.

For earlier gage heights see table on p. 703, *Engineering News-Record*, Apr. 28, 1927.

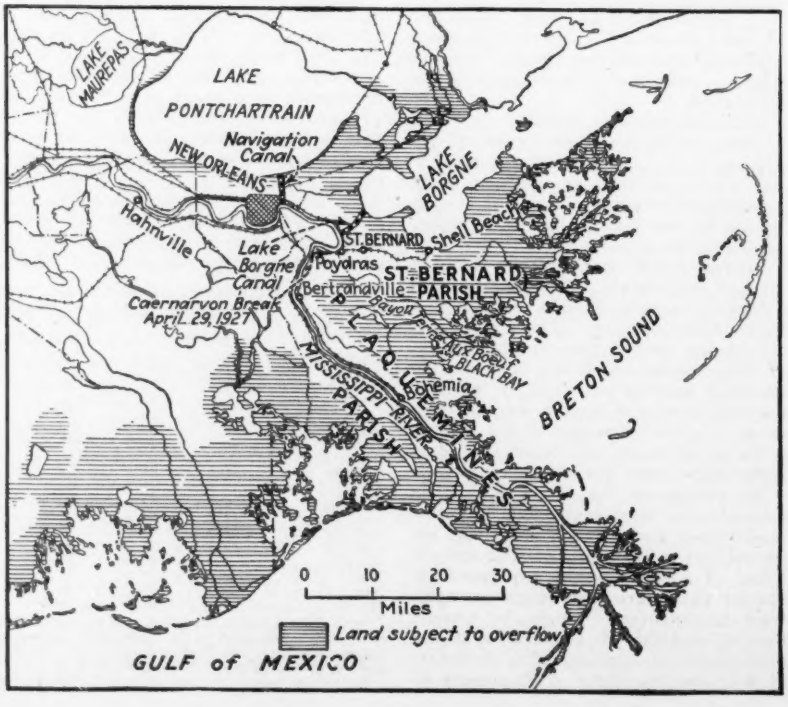

NEW ORLEANS
Navigation Canal
MISSISSIPPI RIVER
Carrollton Gage
El. zero = 0.13 ft. below mean gulf level
Canal St.
8.5 Mi. below Carrollton gage
Gretna
L. Borgne Canal
Caernarvon
Poydras
St. Bernard Ridge
English Turn
St. Clair
PLAQUEMINES PARISH
ST. BERNARD PARISH
Site of Poydras crevasse of April 27, 1922: Attained width of 1,300 ft.; discharge not measured but probably did not exceed 240,000 sec.-ft.; scoured to maximum depth of 90 ft.
Location of artificial crevasse, April 28, 1927: 1,000 ft. of levee blasted out up to May 2; crevasse will be given ultimate width necessary to discharge 240,000 sec.-ft. and hold Carrollton gage to 21.5 ft.
Dalcour
Current
To Breton Sound
L. LERY
Miles
0 1 2
LAKE BORGNE

MISSISSIPPI RIVER IN NEW ORLEANS VICINITY

Above: Contour map showing the location of the Poydras crevasse of 1922 and of the crevasse now being cut at Caernarvon.
Below: Map of the Mississippi delta region showing relation of the Caernarvon break to the lower reaches of the river.

berger, and to the adjutant-general of Louisiana. The entire national guard of the state had been previously called out because of the flood emergency and detachments of national guard and of the coast guard were detailed for duty at the Caernarvon crevasse to protect workers from possible interference. However, no interfence took place. There has really been nothing of spectacular nature in this work. Statements had been given out beforehand, doubtless correctly, that the crest of the flood would be reduced 2 ft. or more at New Orleans, and that the crevasse would attain a discharge of nearly 250,000 sec.-ft. Disparaging reports that have appeared in the daily press can be attributed to the fact that reporters expected to see immediate results and were naturally disappointed. So far as is known all engineers who have viewed the work think it will be successful in given the results for which the break was made. Probably 80 per cent of the discharge from the Caernarvon crevasse will go directly to Breton Sound, while possibly 20 per cent will find its way into Lake Borgne.

[A telegram from Mr. McWhorter sent the night of May 3 reads as follows: "River at Caernarvon crevasse



this morning 8 o'clock was down total of 0.6 ft. since Friday morning, Carrollton gage (New Orleans) reads 20.4 at 2 p.m., down a total of 0.4 ft. since Friday. Baton Rouge was up to 45.4 this morning. That gage read 45.1 Friday morning. Behavior of Baton Rouge gage is due to crevasse below Vidalia and fall there is temporary only. Part of the fall at Carrollton is attributed to sympathy with Baton Rouge. Caernarvon crevasse now 1,500 ft. wide. Batture is scouring more slowly than expected. Discharge estimated about 90,000 sec.-ft. May remove 2,500 ft. of levee. This levee was built of ideal material, and is one of the best in the state."]

Mississippi Flood Crest Passing Vicksburg

(Continued from p. 742)

at Junior on west bank expected to keep river at New Orleans not much higher than flood of 1922."

Conditions in the flood area of Arkansas and Louisiana continue to be disturbing. The flood water is rising in the lower basins and successive areas. Rescue work is being extensively prosecuted under the direction of the American Red Cross and United States Army. Minor levees on all of these tributary rivers and protective levees around towns and villages have broken in many places, but authentic reports are impossible to get.

A.S.T.M. Nominates Officers

The following have been nominated as officers of the American Society for Testing Materials:

For President, H. F. Moore, professor of engineering materials, University of Illinois, Urbana, Ill.; vice-president, T. D. Lynch, manager, materials and process engineering department, Westinghouse Electric and Manufacturing Co., East Pittsburgh, Pa.; executive committee, F. O. Clements, director of research, General Motors Corporation, Detroit, Mich.; W. H. Klein, general superintendent, Dixie Portland Cement Co., Richard City, Tenn.; F. C. Langenberg, metallurgist, Watertown Arsenal, and metallurgist, Climax Molybdenum Co., New York City, and F. N. Speller, metallurgical engineer, National Tube Co., Pittsburgh, Pa.

The thirtieth annual meeting of the society will be held at French Lick, Ind., June 20-24.

Award Prizes for Road Essays

In the competition of essays by college students on "Benefits to a Nation by Improved Highways," as conducted by the American Road Builders Association, the first prize was given to S. A. Lesniewski, of De Pauw University, Chicago. The other six were awarded in order to John R. Shepler, Harvard University; Reginald F. Jacobs, Massachusetts Institute of Technology; Roland Mulhauser, Cleveland, Ohio; Angus Tresidder, Ithaca, N. Y.; Charles Fitzgerald, Chicago, and H. H. Rogers, Raleigh, N. C.

Welding Society Discusses Developments of Art

(Continued from p. 741)

square inch. In comparison, cast steel showed an endurance limit of 32,000 lb. per square inch. Test pieces made from deposited weld metal gave higher endurance limits than the welded tubes.

The development work carried out by the Westinghouse Electric & Mfg. Co. in structural steel welding during the past year was reviewed by A. M. Candy, and the work of the Una Laboratories by R. B. Fehr. D. H. Deyoe sketched at some length the development in welding apparatus of the General Electric Co., much of it designed for continuous welding. He also told of the development of a copper-tungsten spot-welding electrode known as "Elkonite," and showed views of the welded ties tried out on the Delaware & Hudson R.R., made of two lengths of old rail welded together by base connectors at the ends and by tie plates across the heads at the rail seat. J. H. Deppeler reported some of the research activities of the Metal & Thermit Corporation, including improvements in thermit which make it possible to produce sound and high-strength steel every time, and corresponding improvements in refractories and in operating technique.

At the afternoon session papers were read illustrating the application of welding to production work. J. F. Lincoln, Lincoln Electric Co., briefly outlined the advantages obtained by replacing castings with welded steel parts: higher tensile strength and modulus of elasticity, lower cost, and greater safety. There is also an advantage in storage space requirements by the elimination of the patterns for castings.

J. H. Deppeler, Metal & Thermit Corp., showed pictures of ships' rudders in which the tail and shaft were thermit-welded together, and also pictures of crankshafts made by building up a thermit slab for the arms connecting the different parts of the shaft. C. J. Holslag, Electric Arc Cutting & Welding Co., Newark, told of some thirty residences which have been built in the metropolitan area of New York City by electric welding. These buildings were put up much as are wooden frame buildings, by cut-and-try methods in the field.

H. W. Tobey, Pittsfield Works of the General Electric Co., spoke of resistance welding and special machines therefor. One of these has a maximum capacity of two ½-in. plates. Special machines for tack welding, longitudinal seam welding and circumferential seam welding have been developed. M. F. Bayer, Simmons Company, spoke on the oxy-acetylene welding of furniture and Robert Appleton, Pierce Arrow Mfg. Co., on the applications of welding in automobile manufacture. In the latter paper it was stated that flux material is removed from aluminum welding by means of live steam. It was brought out in the discussion that for corners and other places where flux accumulates, it is probably better to use nitric acid as a remover.

D. C. Henny Accepts Los Angeles Flood Control Appointment

D. C. Henny, consulting engineers, Portland, Ore., has accepted appointment as the third member of the board of consulting engineers to the Los Angeles County Flood Control District. Appointment of the other two engineers, J. B. Lippincott and J. W. Reagan, was announced in *Engineering News-Record*, March 31, p. 544.

Will Extend Everglades Drainage by New Bond Issue

A new issue of $20,000,000 of bonds for drainage of the Everglades is authorized by an act just passed by the Florida Legislature. The law provides for the levy of an ad valorem tax on property within the district, in addition to an acreage tax as heretofore authorized. The issue of the bonds and administration of the funds secured thereunder are placed in the hands of the board of commissioners of the Everglades Drainage District. The board may issue bonds also for the purpose of retiring or refunding bonds now outstanding; the $20,000,000 issue, however, is to be additional to all present indebtedness. The only limitation on the bond isue is that the aggregate debt of the district, including the additional bonds, may not exceed 25 per cent of the excess valuation of the real property within the district.

War Department Approves Plans of Vicksburg and Natchez Bridges

Plans for the Natchez bridge across the Mississippi River were approved on April 28 by the Secretary of War and the acting Chief of Engineers. The bridge proper is to consist of one 825-ft. span, two 620-ft. spans, one 350-ft. span and two 250-ft. spans. The horizontal clearance under the main span is 800 ft. The vertical clearance is 116 ft. at low water and 60 ft. at high water. Construction must begin before May 2 and be completed in three years.

Plans for a highway bridge to cross the Mississippi River at Vicksburg were approved by the Chief of Engineers on April 23, with the stipulation that a clearance height of 60 ft. be provided for the length of 1,200 ft., and that a trestle approach be constructed on the west bank to replace a length of embankment. As finally approved, the bridge will have a length of 5,400 ft. with 3,400 ft. of approach on the west bank. There is to be an 800-ft. span and three 400-ft. spans.

Detroit Bridge Project Progress

Ordinances granting the American Transit Co. the right to cross certain streets in Detroit with the approaches to its proposed Detroit-Winsor bridge were passed by the city council of Detroit last week over the mayor's veto. It is said that this is the last step required before beginning actual construction of the bridge.

An order-in-council has been signed by the Dominion government authorizing construction of the bridge.

Decision in Herminghaus Case to Be Appealed

The decision of the California Supreme Court in the famous Herminghaus case (*Engineering News-Record*, Feb. 3, 1927, p. 204) has been appealed to the Supreme Court of the United States, and this tribunal has consented to review the decision. The case was brought to restrain the Southern California Edison Co. from storing flood waters in the upper reaches of the San Joaquin River and Big Creek, one of its tributaries, on the ground that the floods of the river submerged and irrigated riparian lands owned by the Herminghaus estate and others. The California court decided, in agreement with an earlier decision, that the riparian owners had a vested interest in the beneficial submergence of their lands by floods, and in the flow of water through flood channels along the stream course. Much public discussion followed the decision, and plans have been made to amend the state constitution so as to limit water rights to such as are established by beneficial and reasonable use.

Steel Substituted for Concrete for Wanaque Aqueduct

Against strong protests from its chief engineer and consulting engineer, the North Jersey District Water Supply Commission on April 28 voted to use steel instead of concrete for the Wanaque aqueduct. Concrete, at least for the upper portion of the aqueduct, was recommended by Arthur H. Pratt, chief engineer, and Morris Sherrerd, consulting engineer, in 1924 and adopted by the commission. Subsequent proposals to use steel instead of concrete led to postponement of calling for bids. In August or September, 1926, the commission engaged George A. Johnson, New York City, to report on the subject. Mr. Johnson's report was submitted to the commission on April 4 but was not acted upon until April 28. On that date there was before the commission not only the report of Mr. Johnson, but a rebuttal by Messrs. Pratt and Sherrerd, a rejoinder by Mr. Johnson, and a second rebuttal by Messrs. Pratt and Sherrerd.

The commission has refused to give *Engineering News-Record* a copy of these reports, alleging that it did not wish to give them out until the size and route of the proposed conduit have been decided on by the commission, action on those points having been postponed to May 6. From what appears to be a very carefully made summary of the report published in the Newark *Evening News* directly after the meeting of the commission on April 28, the following statement of the differences of opinion between the regular engineers of the commission and their special engineer has been prepared.

Mr. Johnson asserts that the twin steel pipe lines can be built quicker and will be safer in operation because, in case of failure, they can be repaired more quickly than can a concrete aqueduct. He claims that Messrs. Pratt and Sherrerd underestimated the cost of a concrete aqueduct and also that they have overestimated the yield of the Wanaque drainage area. Messrs. Pratt and Sherrerd stand by their cost and yield estimates and their belief that the concrete aqueduct will be perfectly safe and satisfactory. They claim that the two 6-ft. steel pipes proposed by Mr. Johnson will not carry the 150 m.g.d. of water that the commission is under contract to deliver to the municipalities that have contracted with the commission, and will cost more than the concrete aqueduct, which Mr. Johnson admits will carry 150 m.g.d.; they also claim that Mr. Johnson used radical coefficients in computing the carrying capacity of the twin conduits.

The resolution adopted by the commission does not specify sizes, but calls for two steel pipe lines with a capacity of 150 m.g.d. from the Wanaque reservoir to the Great Notch tunnel (already built); two steel conduits of 105 m.g.d from the easterly end of the tunnel to Broad St., Bloomfield, and a single steel pipe line of 97 m.g.d. capacity thence to the existing Belleville reservoir.

Technical Men Decry Salary and Working Conditions

At a mass meeting held by the employees of the Board of Transportation, New York City, at the Labor Temple, April 28, under the auspices of the Union of Technical Men, Local 37, plans were formulated whereby it is hoped better salary and working conditions can be secured. Certain grievances were enunciated which will be taken up with the commissioners of the Board of Transportation by a committee representing the employees of that board, the Union of Technical Men Local 37 and the American Federation of Labor. The special desires of the technical men include general increase in salary, in accordance with a schedule which they have prepared, and relief from the current situation wherein the working day of some of the field men has been lengthened an hour without additional compensation. In this connection it was pointed out that the average salary of men beginning with $1,560 per annum to and including $5,250 per annum, is $2,402.

Other grievances include the fact that "duly qualified men are being appointed to positions at salaries less than the position calls for," and that no allowance is made for sickness. Sick time is deducted from vacation time.

A resolution was passed unanimously condemning the Murray plan of reclassification and salary schedule for technical workers. It was pointed out at the meeting that only 14.7 per cent of the city's technical workers (that class receiving salaries from $2,760 to $3,360 per year) would receive an increase, and that increase would amount to about 12 per cent. The rest of the men would receive no benefit and salaries in certain cases would even be decreased, the technical men reported.

The schedule of the Union of Technical Men proposes the following salaries:

(1). For Engineering Aid and Engineering Assistant, a minimum of $2,150 with an automatic yearly increase of $210 up to a maximum of $3,000;

(2). For an Assistant Engineer, Draftsman or Surveyor, a minimum of $3,001, with an automatic yearly increase of $250 up to $4,000;

(3). For Engineer, a minimum of $4,200. Qualifications for this grade would be graduation from a technical college with 5 years experience, or 3 years attendance at a technical college and 6 years experience, or the equivalent training to be determined by an educational test.

Additional salaries proposed for the grade of Engineer would be a minimum of $5,200 for men engaged in supervising work or in charge of a squad; a minimum of $6,500 for 5 years experience in charge of a minor division or assistant to an intermediate division; and a minimum of $8,000 for men having 4 years experience in charge of an intermediate division.

Abrams Joins International Cement Corporation

Announcement has just been made that Prof. Duff A. Abrams, formerly in charge of the research laboratory of the Portland Cement Association, with headquarters at Chicago, has been appointed director of research of the International Cement Corporation, 342 Madison Ave., New York City.

Prof. Abrams is a graduate of the University of Illinois, Class of 1905, receiving at that time the degree of bachelor of science in civil engineering. In 1909 he received the degree of civil engineer. After some early railroad and bridge work, he became attached to the Engineering Experiment Station of the University of Illinois in 1905, where his research career began.

The resignation of Professor Abrams as research director for the Portland Cement Association was noted in *Engineering News-Record*, March 3, 1927, p. 372.

First Contract Let for Fort Lee Bridge

The first construction contract for the 3,500-ft. Fort Lee bridge across the Hudson River was let by the Port of New York Authority on April 29. This is the contract for the two foundation piers of the New Jersey tower, and was awarded to Silas B. Mason, lowest bidder (see *Engineering News-Record*, April 14, p. 627) at the figure of $1,160,200. Each of the two piers is to be about 90x100 ft. in plan, and is to be sunk to rock at a depth of about 60 ft. Mr. Mason proposes to use the open cofferdam method of constructing the foundation.

Approval has been given by the Board of Estimate and Apportionment of New York City to the location of the New York anchorage of the bridge, as proposed by the Port of New York Authority. The anchorage would be placed in Fort Washington Park, and objection was raised to this location when the application was first submitted to the board. The objections against invasion of the park have since been withdrawn, and the park location has now been approved. New Jersey authorities have approved the plans for the west approach.

A.A.E. Chapter Graduates Evening Classes

Completion of a course of evening classes in bridge design, in salesmanship, and in public speaking, conducted under the auspices of the New York Chapter of the American Association of Engineers during the past winter, was celebrated on April 20 by a certification dinner held at the Fraternities Club, New York. Certificates were awarded to 20 members of the bridge design class, conducted by Dr. D. B. Steinman, and to 22 members of the courses in salesmanship and public speaking, conducted by O. G. Van Campen. Following the awards a stimulating address on engineering education was delivered by W. E. Wickenden director of the educational investigations conducted by the Society for the Promotion of Engineering Education.

Personal Notes

CHARLES G. MASSA, of the firm of Tribus & Massa, consulting engineers, New York City, retired from active participation in the work of the firm on May 1 but will retain a general connection with and interest in its activities. Mr. Massa will devote himself to personal matters and travel. The firm name will be continued, and to its present municipal and utility activities will be added a real estate development under a branch title of L. H. Tribus & Co., Inc.

C. OTHO BENNETT has severed connection as resident engineer with E. M. Ratliff Co., Fayetteville, Ark., and has entered the office of Harrington, Howard & Ash, Kansas City, as draftsman on steel and reinforced-concrete bridges and buildings.

DABNEY H. MAURY, of the firm of Maury and Gordon, consulting engineers, Chicago, Ill., has retired from active practice and after an extensive trip abroad will reside in or near Washington, D. C. While he will not maintain an office he will be available for consultation by those whom may desire his professional services. Mr. Maury has had a long and very successful career in water-supply engineering in this and other countries and is well known for his contributions to published material in the water-supply field. Mr. Gordon will continue the practice of the firm, under title, F. G. Gordon, consulting engineer, Monadnock Building, Chicago, Ill.

DUDLEY P. BABCOCK and HENRY G. BABCOCK have opened offices in New York City as consulting engineers under the name of Babcock Brothers. Dudley Babcock is a graduate of Columbia University in civil engineering, class of 1907. From 1909 to 1919 he was with the New York State Highway Department on Surveys and designs for the Storm King Highway. In 1919 he entered the employ of the Bronx Parkway Commission and since that time has given his attention chiefly to bridge design work. Henry Babcock also is a graduate of Columbia University in the class of 1908. His early experience included hydro-electric power plant construction and two years on subway construction in New York. During the war he served with the Eleventh Engineers in France specializing in the reinforcing of railway structures. From 1919 to 1924 he served as an assistant engineer on the Vehicular Tunnel work at New York and since 1924 with the Westchester Park Commission on bridge design and inspection. The firm will specialize in the design of statically indeterminate structures using the Beggs deformeter method.

WILLIAM H. CONNELL, Harrisburg, Pa., has resigned as engineering executive of the Pennsylvania State Highway Department. He was appointed engineering executive in 1923 and in 1926 when the secretary of the department, P. D. Wright, resigned, Mr. Connell also became acting secretary. In 1912 Mr. Connell was appointed chief engineer of the Bureau of Highways at Philadelphia, Pa., and served there until 1917, then for two years was engineering executive for Day & Zimmermann and the ensuing years until 1923 was special staff engineer of the Philadelphia Rapid Transit organization.

SAMUEL ECKELS, Pittsburgh, Pa., has been made deputy secretary of the Pennsylvania State Highway Department; this is the new title of the position from which W. H. Connell has just resigned, the position formerly being engineering executive under the department secretary, James L. Stuart. Mr. Eckels up to this appointment, effective May 1, had been assistant director in the department of public works of Allegheny County, Pennsylvania. Before entering the county work, Mr. Eckels had for a number of years been in municipal engineering in the city of Pittsburgh.

EDWARD ESTES, who was equipment engineer of the Texas Highway Department under the recent administration, has been appointed assistant industrial commissioner of the St. Louis & Southwestern Railway Co. with headquarters at St. Louis. Mr. Estes had previously been in the service of that road.

O. WILLIAM FREEMAN has terminated his connection in the maintenance-of-way department of the Pennsylvania R.R. and accepted a position with the S. S. Kresge Co. of Detroit, Mich., as construction superintendent.

H. P. FULLER, assistant engineer, Canadian National Rys., at Kamsack, Saskatchewan, has been transferred to the Pas, Manitoba, where he will be employed on construction of the Hudson Bay Ry.

NARCISSE J. A. VERMETTE, has been appointed city manager for Shawinigan Falls, Quebec. Mr. Vermette is a graduate of Laval University, and was for some years with Ouimet and Lesage, consulting engineers, Montreal. Later he was on the engineering staff of the city of Montreal.

R. C. RUTTER has been engaged by Harris County, Texas, as construction engineer on the highway improvements to be made in the county under a recent large bond issue. Mr. Rutter was recently resident engineer on the Lake Pleasant or "Frog-Tanks" dam on the Agua Fria River in Arizona, and before that had charge, for the Salt River Valley Water Users Association, of the construction road into and of the laying out of the Horse Mesa dam and guniting of the canal lining. Other work was done for Ford, Bacon & Davis on the Remmel dam on the Ouachita River in Arkansas and for the firm of John R. Fordyce, Engineer, Inc., of Little Rock and Hot Springs, Ark.

EZRA B. WHITMAN, Baltimore, Md., has been reappointed a member of the Maryland Public Service Commission. Mr. Whitman formerly was chairman of the commission but for the last few years has served as a commissioner.

HENRY JOHNSON, JR., who was an office engineer for Dwight P. Robinson & Co., Inc., at Pittsburgh, has been made senior assistant engineer of construction in the Bureau of Bridges and Structures of the city of Pittsburgh, Pa.

Engineering Societies

Calendar

Annual Meetings

NATIONAL CONFERENCE ON CITY PLANNING, New York City; Annual Meeting, Washington, D. C., May 9-11, 1927.

NATIONAL FIRE PROTECTION ASSOCIATION, Boston, Mass.; Annual Meeting, Chicago, Ill., May 9-12, 1927.

SOCIETY OF INDUSTRIAL ENGINEERS, Chicago, Ill.; Annual Meeting, Chicago, Ill., May 24-27, 1927.

CONFERENCE OF STATE SANITARY ENGINEERS, Washington, D. C.; Annual Meeting, Chicago, Ill., June 4-6, 1927.

AMERICAN ASSOCIATION OF ENGINEERS, Chicago, Ill.; Annual Convention, Tulsa, Okla., June 6-8, 1927.

AMERICAN INSTITUTE OF QUANTITY SURVEYORS, Chicago, Ill.; Annual Meeting, Washington, D. C., June 6-8, 1927.

AMERICAN WATER WORKS ASSOCIATION, New York City; Annual Meeting, Chicago, Ill., June 6 to 11, 1927.

AMERICAN SOCIETY FOR TESTING MATERIALS, Philadelphia, Pa.; Annual Meeting, French Lick, Ind., June 20-24, 1927.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION, New York City; Annual Meeting, Orono, Maine, June 27-30, 1927.

The Minnesota Section of the American Water Works Association will hold its annual meeting at the Armory, Minneapolis, June 15. Ronald M. Finch, 126 S. Ninth St., Minneapolis, is secretary.

The Engineers' Society of Northern Minnesota at its meeting April 23 at Hibbing, Minn., was addressed by G. H. Herrold, city planning engineer, St. Paul, Minn., on the subject of "City Planning and Zoning."

The New York Section of the American Welding Society will on May 17 have a paper on "The Welding of the Mokelumne Pipe Line" by Prof. L. T. Jones and Prof. W. S. Weeks, of the University of California.

Construction Equipment and Materials

A Section Devoted to What the Manufacturer is Doing for the Engineer and Contractor

Exhibitors Applying for Space at Waterworks Convention

The following list of firms has so far applied for exhibit space at the convention of the American Water Works Association to be held at the Hotel Sherman, Chicago, June 6-11.

National Water Main Cleaning Co.
U. S. Cast Iron Pipe and Fdry. Co.
R. D. Wood & Co.
The Leadite Co.
Gamon Meter Co.
LaMotte Chemical Products Co.
A. P. Smith Mfg. Co.
Federal Meter Corp.
Central Foundry Co.
Mueller Co.
Simplex Valve & Meter Co.
W. P. Taylor Co.
East Jersey Pipe Co.
A. D. Cook, Inc.
The Kennedy Valve Mfg. Co.
W. & L. E. Gurley.
Sullivan Machinery Co.
Wallace & Tiernan Co., Inc.
National Tube Company.
Chicago Bridge & Iron Works.
Michigan Valve & Foundry Co.
The Pitometer Co.
Ross Valve Mfg. Co., Inc.
De Laval Steam Turbine Co.
R. W. Cramer & Co., Inc.
Lead Lined Iron Pipe Co.
Vogt Brothers Mfg. Co.
Layne & Bowler Mfg. Co.
Builders Iron Foundry Co.
National Meter Co.
Rensselaer Valve Co.
Badger Meter Mfg. Co.
Traverse City Iron Works.
American Well Works.
Ludlow Valve Mfg. Co.
Birch Manufacturing Co.
Barber-Greene Co.
McWane Cast Iron Pipe Co.
Waterous Fire Engine Works.
Eddy Valve Co.
Hays Manufacturing Co.
Hersey Manufacturing Co.
Pittsburgh-Des Moines Steel Co.
Lock Joint Pipe Co.
Joseph Dixon Crucible Co.
Pittsburgh Testing Laboratory.
Automatic Cone Valve Co.
H. W. Clark Co.
Worthington Pump & Machinery Corp.
Edward E. Johnson, Inc.
American Cast Iron Pipe Co.
Hydraulic Development Co.
The Fred W. Hanks Co.
Ohio Varnish Co.
William H. Carter.
Neptune Meter Co.
Thomson Meter Corp.
Geo. H. Snell.
Iowa Valve Co.
Joseph G. Pollard Co., Inc.
Edson Manufacturing Corp.
Burroughs Adding Machine Co.
United States Silica Co.
F. B. Leopold Co., Inc.
Pittsburgh Equitable Meter Co.
Penstock Construction Co.
Petroleum Iron Works Co.
International Filter Co.
Union Water Meter Co.
Buffalo Meter Co.

The Chicago convention committee has addressed a special letter to all the members of the Manufacturers Association requesting those who exhibit regularly to arrange for a larger exhibit this year. It has also communicated with 300 national advertisers of waterworks equipment who are not members of the American Water Works Association, inviting their attention to the association's activities. There were 2,000 letters sent to mayors and city engineers, and about 6,600 mailed to waterworks superintendents in the Middle West, as well as to the members of the American Water Works Association regarding the convention. Letters are also being prepared for mailing to all state health officers in the United States.

Business Notes

WILLIAM GOODMAN vice-president, Worthington Pump & Machinery Corporation, New York, died Apr. 21 after an operation in a New York hospital. Mr. Goodman was in charge of the manufacturing end of the Worthington company's business. Under his direction some of the most important developments in the company's equipment were made.

EQUITABLE METER & MFG. CO., Pittsburgh, Pa., has recently changed its name to the Pittsburgh Equitable Meter Co. and has also purchased the assets of the Pittsburgh Meter Co. Both plants will be operated and all products for regulating and measuring both gas and water, which are manufactured by both companies, will be continued.

PARADON MANUFACTURING CO., which some time ago took over the manufacture, sales and service of the chlorinators formerly handled by the Paradon Engineering Co., Long Island City, N. Y., has recently moved its offices and factory to Arlington, N. J. The new headquarters will enable the company to expand its work considerably.

REED-PRENTICE CORP., Worcester, Mass., has appointed the following Pacific coast distributors for its portable link sawing machine: Shaw-Palmer-Bakewell Co., Los Angeles; A. L. Young Machinery Co., San Francisco; P. Sinnock & Co., Portland, Ore.

UNITED ROCK ASPHALT CO. has recently been formed with headquarters in Louisville, Ky. William E. Massey, president, Rock Asphalt Co. of America, is chairman of the board of directors of the new company, which has absorbed his company. The company has plants at Green River, in Edmondson County, Ky., at Black Rock, Ky., and at Decatur, Ala.

EARL E. KNOX, for 20 years representative of the Bury Compressor Co., Erie, Pa., in the Pittsburgh district, has been appointed general sales manager with offices at Erie, Pa.

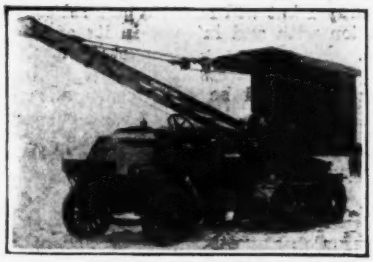
THE CLIMAX ENGINEERING CO., Clinton, Iowa, has just completed arrangements with the Koehring Co. Associates, 50 Church St., New York City, to handle the sale of Climax engines, power units, and accessories for export exclusively in the following countries: Argentina, Colombia, Italy, Panama, India, Philippine Islands, and Japanese Empire.

NOVO ENGINE CO., Lansing, Mich., announces the appointment of the Construction Equipment Co., Columbia, S. C., as a distributor.

New Developments

Truck-Crane as Eight-Wheel or Crawler Mounted Unit

An attachment for the rear wheels of motor trucks which gives either an eight-wheel rubber-tired truck or a high speed crawler has been developed by the United States Wheel Track Layer Corp. in co-operation with the Universal Crane Co., Cleveland, which latter company has charge of the distribution of the product. Each of the six rear wheels, four large and two small, carry an equal part of the load. On a truck-mounted crane it is estimated that 90 per cent of the load is over the rear axle, so that each wheel



carries approximately 15 per cent. Equipped in this manner, the machine may be driven over the highways at a speed of approximately 15 m.p.h.

The crawler tread may be attached or removed in 5 min., the only operation necessary being to drop the tread over the wheels so that the teeth mesh with the slot in the special wheels and insert one connecting pin in place. The bearing area of each tread is 15 in. wide and 70 in. long. With the crawler tread attached the speed of the unit is approximately 8 m.p.h. This unit is applicable to any standard four-wheel truck. The first unit is now working on New York subway construction.

Wheel-Load Scales for Auto Trucks

Laws limiting the total load on any vehicle wheel, effective in many states, have created a necessity for portable weighing devices to check the weight of heavy truck loads. Fairbanks, Morse & Co., Chicago, has recently developed a new portable wheel-load scale as shown in the accompanying

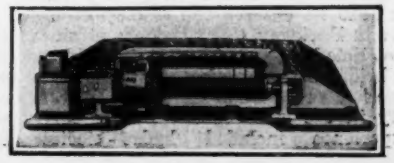
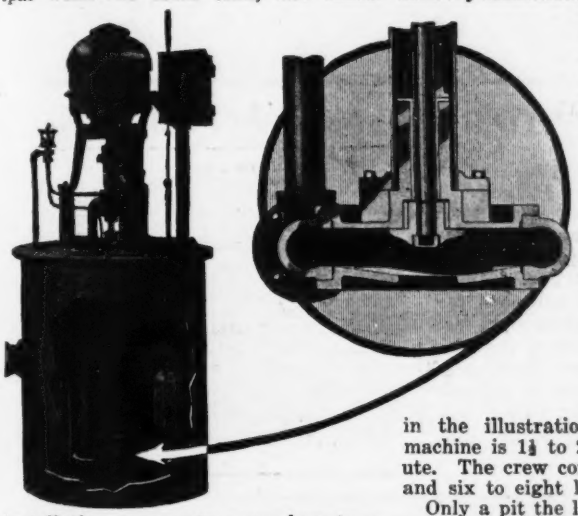


illustration. The scale is easily handled by one man and will weigh loads up to 15,000 lb. The scales are constructed of duraluminum. The weight is recorded on a beam graduated to 50 lb. increments. A smaller size of scale, with a capacity of 10,000 lb., is also manufactured.

Screenless Sewage Ejectors for Building Service

A new screenless centrifugal sewage ejector has recently been developed by Yeomans Brothers Co., Chicago, for installation in large office and manufacturing buildings. Although screenless sewage pumps have been used in municipal work for some time, this small



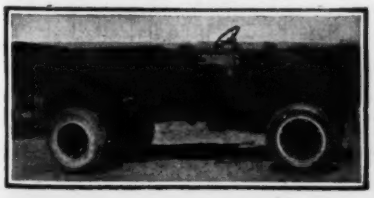
installation represents a new departure.

The pumps are suspended in a cast-iron catch basin. They can be lifted out by raising the basin cover without removing the drainage from the basin. Pump, motor shafts and bearings are assembled on the basin cover so that alignment is assured. A float operated automatic starter controls the motor. In the duplex equipment illustrated, if one unit fails to handle the inflow, the other will cut in automatically.

The type of impeller used permits the passage of stringy material and solids. The capacity of the single ejectors ranges from 150 to 300 g.p.m., while the duplex installations have a capacity of 300 to 700 g.p.m.

Truck Body Especially Designed for Wet Concrete Haulage

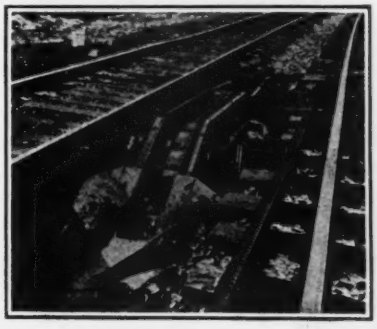
Much of the concrete pavement in Wichita Falls, Tex., has been laid with concrete mixed at a central plant. In order to eliminate sloppage losses, the contractor and owner of the central mixing plant, L. E. Whitham & Co., designed a steel rear-dumping truck body with inward beveled sides. The capacity of the body is 1½ yd. and it is made of ⅜-in. steel plates with the corners welded as shown. A reinforcing angle is riveted around the top of the body. An air cylinder hoist is used and a high dumping angle is obtained. Ten of these bodies mounted on Wichita trucks as manufactured by the Wichita Falls Motor Co. are used by L. E. Whitham & Co.



Machine for Cleaning Ballast in Inter-Track Space

A new machine known as the McWilliams Mole manufactured by the Railway Maintenance Corp., Pittsburgh, Pa., excavates and cleans ballast from end to end of ties in the inter-tract space, to an adjustable depth of five to fourteen inches below the bottom of the ties, clearing trains on all sides while in operation. The machine separates the ballast and the dirt, returning the ballast to the road-bed, and elevating the dirt to carry boxes one of which is shown at the far end of the machine in the illustration. Capacity of the machine is 1½ to 2½ lineal ft. per minute. The crew consists of an operator and six to eight laborers.

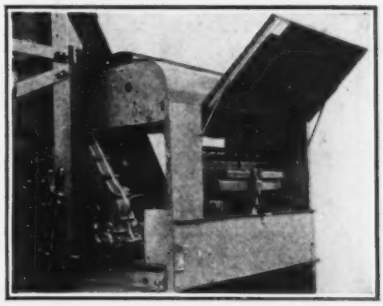
Only a pit the length of the machine is open at any time thus eliminating



chance of track settlement. Sixty feet of tread rail are laid at one time. The entire frame work and head of the machine are made of electric steel castings, all gears are enclosed and operate in oil. The power plant consists of a 15-hp. 4-cylinder motor equipped with air cleaning devices. It is claimed that the churning action effected by the excavating head completely loosens the dirt from the stone so that only the dirt is removed.

Improvements for New Model 27-E Paving Mixer

A new foldback top, power take-off and 6-cylinder engine are some of the important features on the new 1927 27-E paver manufactured by the Chain Belt Co., Milwaukee, Wis. It is claimed that the paver is the fastest yet built by the company. In addition to its speed, new features have been added to synchronize the charging and discharging operations so that two batches are going through the paver all the time. The levers, which are bronze mounted



SIX-CYLINDER POWER PLANT AND DIRECT GEAR REDUCTION ON NEW PAVING MIXER

to permit smooth operation and control, are so grouped as to permit the two or more operations to take place at once.

The new unit power plant employs a 6-cylinder gasoline engine with a power take-off as a part of the unit. The power take-off consists of direct speed reduction through gears, inclosed in a case and running in oil. It is claimed that this arrangement has completely eliminated vibration. The new foldback top is entirely power operated. The water system rests crosswise on this foldback top. Other important improvements are heat treated steel mixing blades and buckets, drop forged gears, alloy steel shafting, and a spiral lime-proof cooling system, the latter being especially valuable for cold weather work since water of an even temperature may be used in mixing the batches.

New Publications

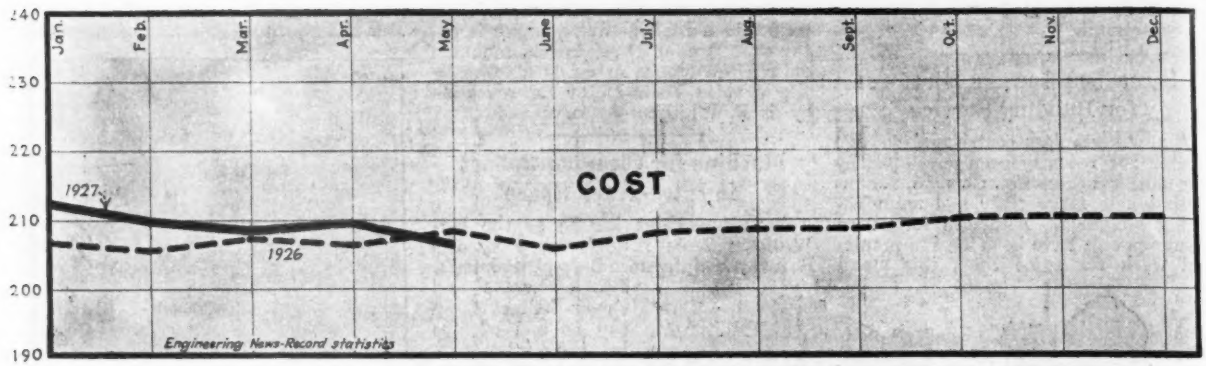
Paving Guards—W. S. GODWIN CO., INC., Baltimore, Md., in its booklet 27, devotes 60 pp. to describing its different type paving guards for use with various types of surfaces and in various positions in the roadway. Photographs, cross-sectional drawings and text are used to describe the paving guards for such uses as road widening, expansion joints, surfacing old roads, transverse headers, separating city and railway paving, for railroad grade crossings, concrete curbs, safety islands, sewer inlets and columns, etc.

Expansion Joints—SERVICISED PRODUCTS CORP., Chicago, Ill., has issued a 40-p. catalog describing its various types of pre-formed expansion joints. All of the various types are illustrated and described as well as are center strips, rail fillers, pipe joint fillers, road marking paints, etc.

Trench Pumps—DOMESTIC ENGINE & PUMP CO., Shippensburg, Pa., devotes a new bulletin, 27-T, to its power-driven trench pump units, both diaphragm and force pump types.

Engineering News-Record Statistics of the Construction Industry

May 5, 1927 *in the United States* Vol.98, No.18



Engineering News-Record CONSTRUCTION COST Index Number (1913 = 100)

MONTHLY

January, 1926 to Date

May, 1927	206.80
April, 1927	209.00
May, 1926	207.30
Peak, June, 1920	273.80
1913	100.00

1926

Jan.	207.15	May	207.30	Sept.	208.30
Feb.	206.55	June	204.80	Oct.	209.80
Mar.	207.65	July	207.80	Nov.	210.80
April	207.05	Aug.	208.30	Dec.	210.80

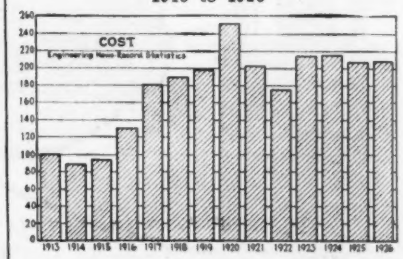
1927

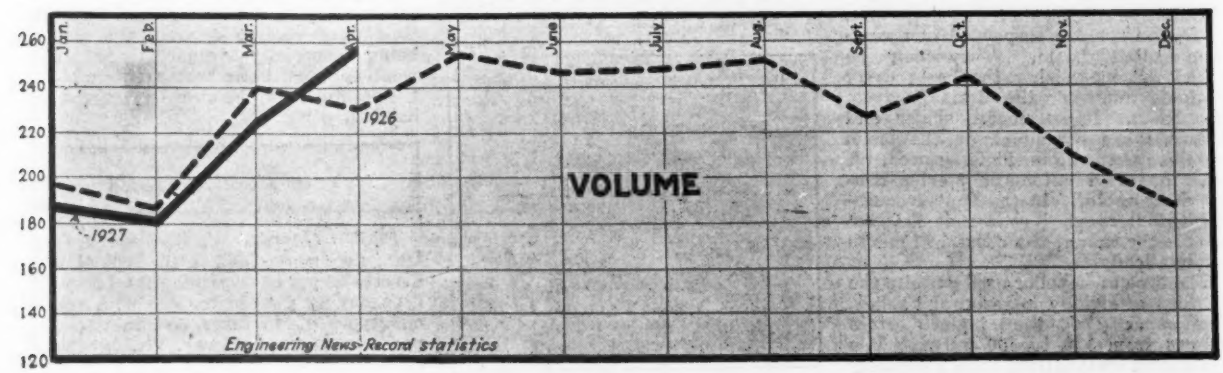
Jan.	211.50	Feb.	210.15	Mar.	208.80

Engineering News-Record's Construction Cost Index Number is one per cent below April, 1927. The decrease is due mainly to lower lumber prices and wages of common laborers. The average rate for the latter is now 55½c. per hr., against 55c. at this time last year. Skilled labor rates threaten to move even higher. Thus, general construction cost is 0.2 per cent below May, 1926, 24 per cent under the peak and 106 per cent above 1913.

YEARLY

1913 to 1926





Engineering News-Record CONSTRUCTION Volume Index Number (1913 = 100)

MONTHLY

January, 1926 to April, 1927

April, 1927	257
March, 1927	226
April, 1926	233
Peak, August, 1925	266
1913	100

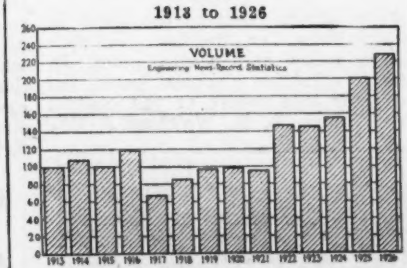
1926

Jan.	198	May	254	Sept.	227
Feb.	187	June	246	Oct.	244
Mar.	240	July	248	Nov.	211
April	233	Aug.	252	Dec.	188
January, 1927	187	February, 1927			182

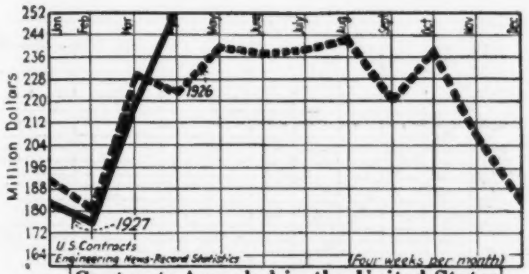
Engineering News-Record's Construction Volume Index Number is 257 for the month of April and 228 for the whole of 1926, as against 100 for 1913. This means that the actual volume of contract letting in 1926 (not the mere money-value of the contracts let that year) is 128 per cent above the volume for 1913. The monthly volume number, 257 for April, 1927, contains the increment of construction and indicates the rate at which contracts are being let as compared with 1913 awards.

YEARLY

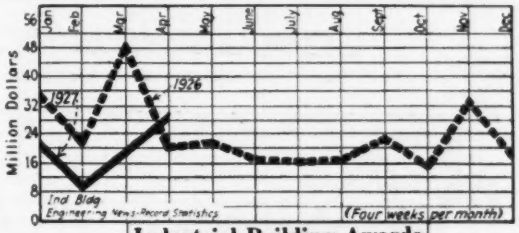
1913 to 1926



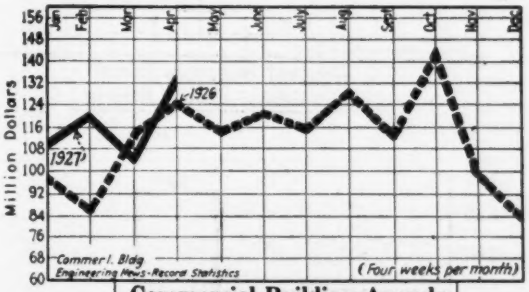
Monthly Statistics of the Construction Industry



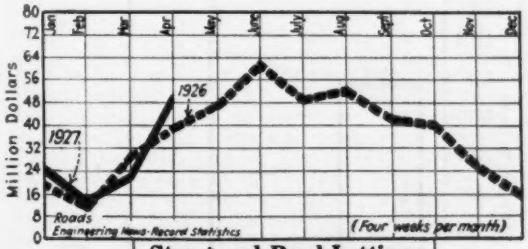
Contracts Awarded in the United States
Reported by E. N.-R.



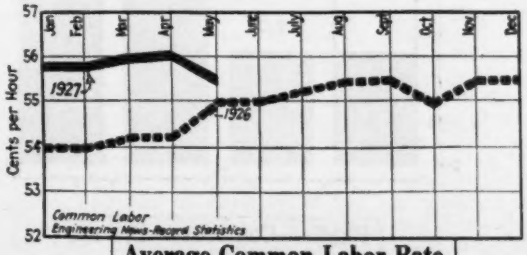
Industrial Building Awards
$40,000 and Over



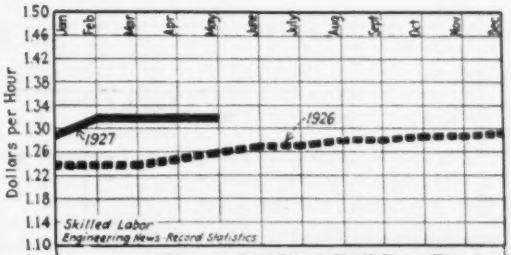
Commercial Building Awards
$150,000 and Over



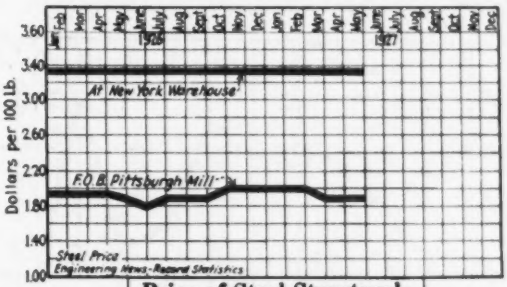
Street and Road Lettings
$25,000 and Over



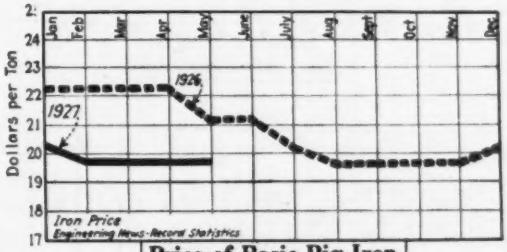
Average Common Labor Rate
Pick and Shovel Men



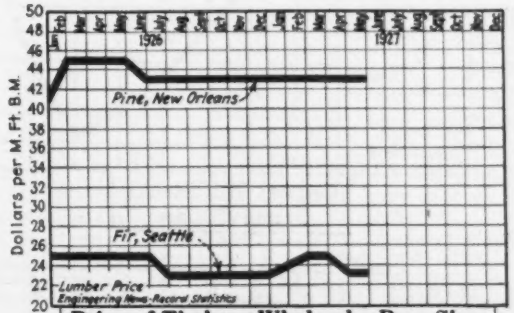
Average Wage of Skilled Building Trades
Bricklayers, Carpenters and Steel Erectors



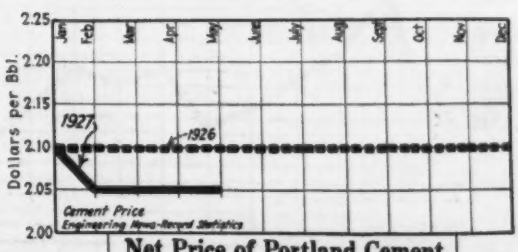
Price of Steel Structurals
Shapes 3-in; Plates ¼-in.



Price of Basic Pig Iron
F.o.b. Pittsburgh

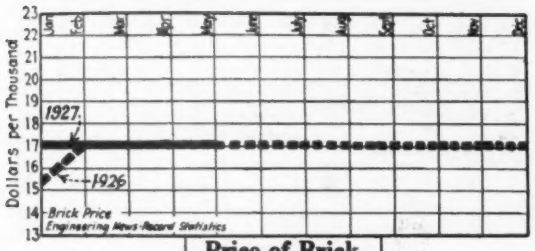


Price of Timbers, Wholesale, Base Sizes
Car Lots to Contractors

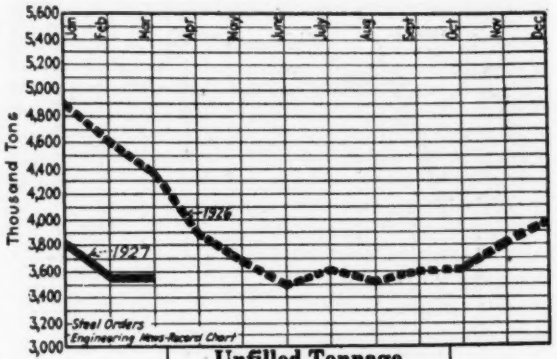


Net Price of Portland Cement
Car Lots F.o.b. Chicago

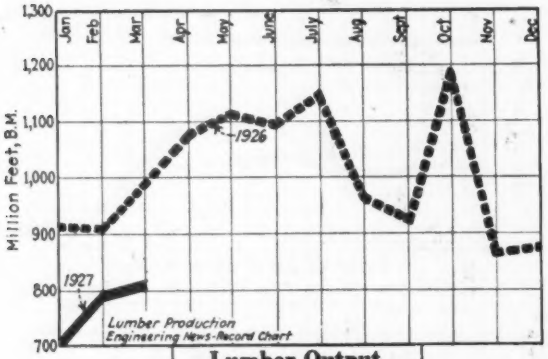
Monthly Statistics of the Construction Industry



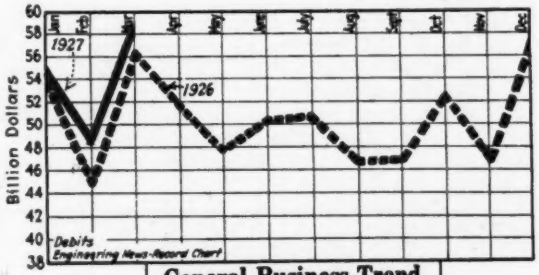
Price of Brick
At Dock, New York



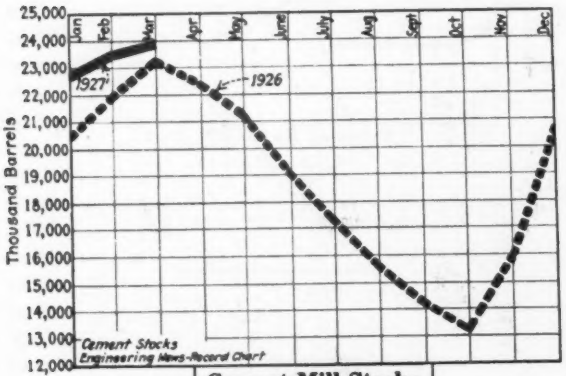
Unfilled Tonnage
On Books of U. S. Steel Corp.



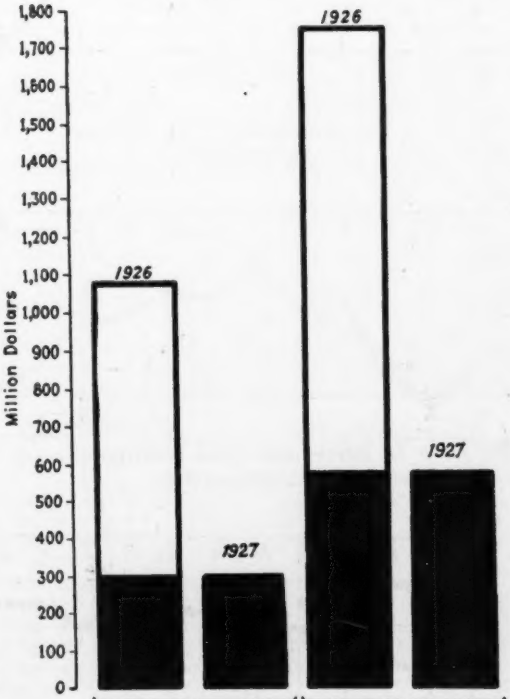
Lumber Output
Nat. Lumber Mfrs. Assn.



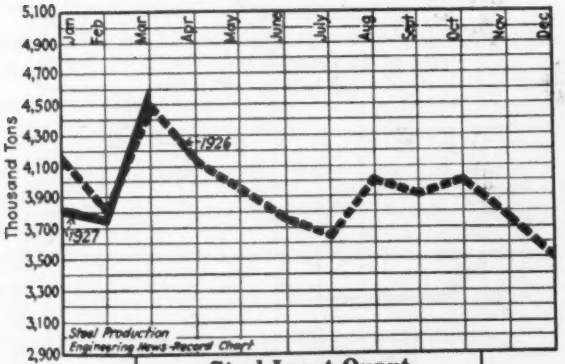
General Business Trend
Bank Debits—Federal Reserve



Cement Mill Stocks
Bureau of Mines



Public—Contracts—Private
Jan. 1 to date ——
Reported by E. N.-R.



Steel Ingot Ouput
Gross Tons; Am. Iron and Steel Inst.

Heavy Construction Keeping Pace With 1926

Activity Largely in Public Work

THE beginning of the fifth month finds construction, as measured by money value of contracts let, so close to the mark reached at this time last year, that the difference is negligible.

The term construction, as used here, is applicable to work at a minimum value for each class, as follows: waterworks, excavations, drainage, irrigation, levee, river and harbor projects, $15,000; other public work, $25,000; industrial buildings, $40,000; commercial, educational, religious, and other buildings, $150,000.

At the minimum values mentioned, heavy construction for the period Jan. 1 to May 1, 1927, entire U. S., reached a cumulative total of $877,271,000, as against $881,045,000 for contracts let in the corresponding period last year. The drop is less than one per cent. At the same time, average construction cost for the four-months period, is an even one per cent under that for the same months in 1926. The slight decrease in total costs, due to excess of price declines in materials over advances in labor rates, indicates more than ever that just as much actual construction is already under way or is about to be started, as in 1926.

In this section of the paper, contract totals for the week ending with the date of issue, are regularly given. On this basis, the weekly average for April, 1927 was $61,706,000 as against $54,688,000 in March and $56,009,000 during April, 1926.

Proposed work averaged $109,188,000 weekly, during the month of April, 1927, for the entire country at the minimum mentioned in each class. Proposed projects include buildings on which permits are required and also the many forms of construction on which no permits are necessary. About half of the proposed work falls through, however, before reaching the contract stage. The average weekly rate of proposals during April, 1926, was $111,328,000; here the difference between this year and last is only a matter of a trifle over one per cent.

The accompanying table shows comparisons of construction activity in various sections of the country. By classes, however, April gains were notable in sewers, bridges, excavating projects, streets, roads, and public buildings, in fact, the increases were largely in publicly owned projects. Sectionally, the states where the gains actually occurred were Maine, New Hampshire, New Jersey, Pennsylvania, North Carolina, Florida, Alabama, Louisiana, Tennessee, Ohio, Indiana, Wisconsin, Michigan, Kansas, Montana, Idaho, Nevada, and Washington.

VALUE OF CONTRACTS AWARDED BY CLASSES, APRIL, 1927

	New England	Middle Atlantic	South	Middle West	West of Mississippi	Far West	United States	Jan. 1 to Date, U.S.	Canada
Waterworks	$580,000	$1,153,000	$70,000	$686,000	$784,000	$225,000	$3,498,000	$20,305,000	$156,000
Sewers	.....	6,514,000	.....	4,651,000	971,000	468,000	12,604,000	32,606,000	155,000
Bridges	103,000	1,841,000	475,000	4,177,000	603,000	33,000	7,232,000	29,252,000	50,000
Excavations, drainage, irrigation	.....	330,000	5,154,000	37,000	1,486,000	38,000	7,045,000	15,504,000	137,000
Streets and roads	1,079,000	10,979,000	12,095,000	13,715,000	7,333,000	5,568,000	50,769,000	116,552,000	2,186,000
Industrial buildings	2,931,000	6,274,000	1,445,000	9,412,000	1,638,000	1,740,000	23,440,000	79,044,000	2,675,000
Commercial buildings	11,787,000	47,078,000	6,283,000	37,852,000	13,133,000	17,687,000	133,820,000	496,434,000	1,860,000
Federal Government	49,000	2,328,000	328,000	315,000	206,000	375,000	3,799,000	14,263,000	.....
Unclassified	295,000	1,015,000	45,000	1,638,000	659,000	964,000	4,616,000	82,311,000	2,823,000
April, 1927	$16,824,000	$77,512,000	$25,895,000	$72,483,000	$26,813,000	$27,296,000	$246,823,000	$877,271,000	$10,042,000
March, 1927	21,984,000	84,256,000	16,769,000	56,944,000	63,304,000	30,181,000	273,438,000	.....	5,309,000
April, 1926	27,471,000	73,176,000	24,745,000	66,349,000	48,169,000	40,136,000	280,046,000	.....	16,684,000
Jan. 1 to date, 1927	67,270,000	255,588,000	76,388,000	215,383,000	144,681,000	117,981,000	877,271,000	.....	23,973,000
Jan. 1 to date, 1926	56,283,000	307,146,000	107,193,000	191,232,000	118,808,000	100,383,000	881,045,000	.....	39,638,000

Labor Rates and Conditions Throughout the Country

Building Crafts Demand Higher Rates in Several Cities

SERIOUS strikes and wage controversies, occurring during the last month, in various localities throughout this country and Canada numbered exactly seven, as did the settlements reached in that time between employers and building trades mechanics.

The assertion that heavy construction is keeping pace with the 1926 rate of lettings, applies to the nation as a whole, since in some districts local conditions form exceptions to the rule.

Slowing down continues in Philadelphia, for instance, while St. Louis, one of the highest building-trades wage centers, reports dull prospects for the coming summer.

Minneapolis, however, predicts a new building construction record for 1927. In the Seattle district, road and building construction are in close competition with agriculture for services of laborers. This city, together with the Puget Sound region, reports an encouraging outlook in industrial and commercial building for the late spring and summer.

A brief outline of the principal wage demands and strikes, follows:

New York, N. Y.—Local No. 37, Union of Technical Men, employed by the Board of Transportation on subway construction, demands a 30 per cent wage increase but without intentions of resorting to a strike. Union plumbers in this city, to the number of 5,000, were locked out Apr. 28 by the employers, following a strike in Brooklyn in which this trade demanded a wage advance of $2 per day, over the present rate of $12, together with the five-day week. Trouble with the Brooklyn painters has been averted by court injunction restraining a strike.

Scranton, Pa.—Carpenters on strike for wage advance of $1 per day, from the present scale of $9. Electricians anticipate negotiations with regard to a similar increase.

Syracuse, N. Y.—Painters on strike since Apr. 1, demand increase of 15c. per hr., above the present scale of $1.10. Ironworkers also demand 12½c. per hr. over $1.25 and common laborers, 15c. per hr. from 70c., received at present. Stone cutters are also included in the movement.

Troy, N. Y.—Painters demand $2 per day increase over present rate of $8.

Minneapolis, Minn.—Plasterers ask increase of $1 over present wage of $11 per day; no strike involved.

Monmouth Co., N. J.—Strikes in four shore resorts, involving six building trades, started in sympathy with demand of laborers for an advance of $1 per day above the old rate of $7.

Montreal, Que. — International Brotherhood of Carpenters demands written agreement at a flat rate of 75c. per hr., as against the varying scale now in force, in which the rate is determined by the degree of skill possessed by the operative.

Principal settlements reached during the month were as follows:

Cleveland, O. — Ironworkers are signed up at the prevailing scale for two years. Plumbers are also under agreement for twenty-one months from May 1, at current rate of $1.50 per hr.

Cincinnati, O.—Nineteen grades of building laborers are under contract to receive present rates until May 23, 1928.

Newark, N. J.—Master carpenters organizations in Newark, Orange, Montclair, Belleville and Nutley agree to a wage advance of 80c. per day over the present rate of $11.20, effective July 1, 1927.

Paterson, N. J.—Plumbers are signed up for one year beginning May 1 at $12 per day and the 44-hr. week. Passaic and Bergen County painters received increases, Apr. 11, of $1 per day from $11.

Rochester, N. Y.—Seven trades have entered into agreements with employers to maintain 1926 rates throughout the current year.

Riverhead, N. Y.—Union carpenters of eastern Long Island were granted a $1 increase to $10 per day.

Current Building Trades Wage Rates Per Hour

(Higher rates than a month ago indicated by +, decreases by—)

Cities	Bricklayers	Carpenters	Hoisting Engineers	Hod Carriers	Pile Drivers	Structural Iron Workers	Common Labor
Atlanta	$1.40	$0.70	$0.70	$0.50	.....	$0.75	$0.25@.30
Baltimore	1.62½@1.75	1.00@1.10	1.00@1.37½	1.00	$0.65	1.00@1.25	.40
Birmingham	1.00@1.50	1.05	1.00	.50@.75	.....	1.75	.25@.40
Boston	1.40	1.25	1.25	.79	1.15	1.25	.45@.74
Cincinnati	1.50	1.35	+1.35	+.97½	+1.35	+1.35	+.45@.60
Chicago	1.62½	1.10@1.50	1.00@1.50	.90@.96¼	1.50	1.50	.90
Cleveland	1.50	1.25	1.30	.87½	1.10	1.50	.87½
Dallas	1.62½	1.12½	1.00	.40@.75	1.00	1.25	.30@.50
Denver	1.50@1.62½	1.25	1.25@1.37½	.87½@1.00	.....	1.25	— 31¼@.50
Detroit	+1.56¼	+1.00@1.25	+1.00@1.10	.90	1.00@1.10	+1.00@1.25	+ 50@.60
Kansas City, Mo	1.50	1.25	1.25	.90	1.25	1.25	.40@.75
Los Angeles	1.37½	1.00	1.00	.87½	.87½	1.00	.50
Minneapolis	1.25	.87½@95	.87½	.75	....	1.00	.45@.60
Montreal	+1.00@1.25	.75	.60	.40	.50	.75	.25@.30
New Orleans	1.50	.90	1.00	.75	.80	1.25	.30@.40
New York	1.75	1.50	1.75	1.12½	1.00@1.12½	1.75	.90¾
Philadelphia	1.62½	1.12½@1.25	1.02½	.70@1.12½	1.00	1.37½@1.50	.45@.50
Pittsburgh	1.62½	1.50	1.37½@1.50	1.12½	....	1.50	.80
St. Louis	1.75	1.50	1.50@1.65	1.15@1.25	1.25	1.50	.40@.75
San Francisco	1.37½	1.12½	1.00@1.06¼	.87½	1.12½	1.37½	.50@.60
Seattle	1.37½	1.12½	1.00@1.12½	1.00	1.00@1.12½	1.12½	.62½

Kansas City, Mo.—All building crafts are under agreement with the employers to maintain 1926 rates throughout the present year. All questions on jurisdictional disputes are to be settled without cessation of operations.

Monthly Prices of Construction Materials

Downward Trend Remains Unbroken

BUILDING materials prices show no tendency, as a group, to break the downward trend started in September, 1926.

Brick offers the one exception, in that it is a trifle higher than a year ago in several of the principal markets. There is evidently little chance of an abrupt advance in brick prices since incoming foreign material serves to hold the market down. It is worth noting, however, that in the latest report of the Foreign Commerce Department of the Chamber of Commerce of the U. S., brick is conspicuously absent from the "one hundred chief imports."

Easing of materials prices, counteracted by higher labor rates, has resulted in a cost movement having a very narrow margin of fluctuation, over a period of very nearly a year and a half. In fact, the variation has not exceeded five points during the time mentioned, as shown by the chart of the E. N.-R. Construction Cost Index Number on p. 750. Steadiness of cost, labor and materials combined, is consistent with sustained demand as indicated by money value of contracts awarded. Lettings for the nation as a whole, totaled for the first seventeen weeks of this year, are a small fraction of one per cent under the corresponding period in 1926. Another indication of the continued heavy construction demand is the lack of appreciable unemployment among skilled building trades mechanics, barring a few exceptional situations, mostly local in character.

Steel production reached its seasonal peak in March and has since been on the decline. Unfilled orders at mills are also lighter, yet sufficient reserve stocks of ingots are being held against a possible emergency arising out of the present soft-coal miners' strike. Little tendency toward price fluctuation is evident in the principal forms of building steel.

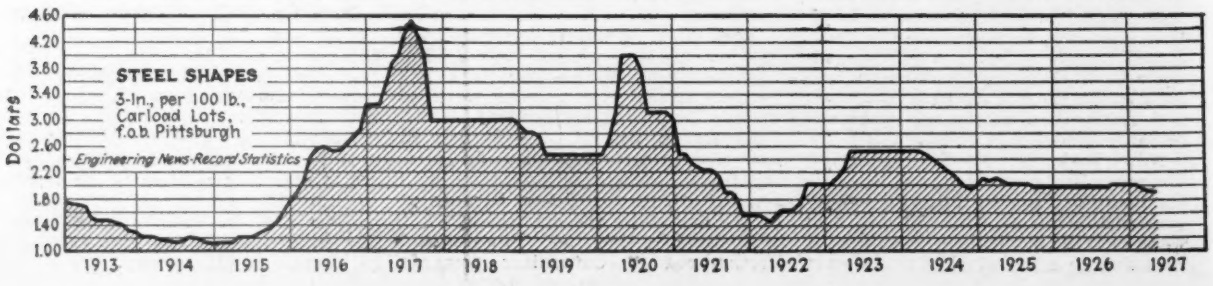
Cement shipments are slightly under mill output, with the result that reserve stocks on hand April 1, at plants throughout the country, were the heaviest for that date on record. This does not indicate firmer prices for portland cement even though volume of construction demand is nearly up to the point reached at this time last year.

Brick production is sufficiently ahead of orders and shipments, at yards through the ten great brick districts, to leave heavier stocks than at this time in 1926.

Hardwood lumber prices are due to rise, unless further recession in frame building construction develops during the next month. Mississippi floods have caused the shutting-down of exactly 100 hardwood mills, between April 22 and May 2, throughout Arkansas, Louisiana, Texas, Mississippi, Alabama, Tennessee, and Missouri. In the Pacific Northwest an attempt has been made to stabilize the declining lumber market by instituting a three-day closing of mills in the Douglas fir areas. Softwood lumber production is obviously slowing down to a point consistent with current demand; prices, however, remain weak.

The principal price advances of the month occurred in railway ties, structural rivets, and linseed oil. In the latter, the Argentine flax price rose, carrying with it the domestic linseed market at Minneapolis. Declines affected mainly scrap, cast-iron pipe in Mid-Western cities, road oils, hollow tile, reinforcing bars rolled from rails, wire nails, black and galvanized sheets.

The diagram following, shows the mill price of structual steel resting slightly above the January, 1913, level. Four major price declines and three great advances have occurred since the beginning of the last pre-war year.



E. N.-R. Prices of Construction Materials

Price advances since last month are indicated by **heavy type**; declines by *italics*

PIG IRON—Per Gross Ton f.o.b.:

	May 5	One Year Ago
CINCINNATI		
No. 2 Southern (silicon 2.25@2.75)	$22.19	$24.05
Northern Basic	20.89	24.27
No. 2 Southern Ohio (silicon 1.75@2.25)	21.19	24.27
NEW YORK, tidewater delivery		
Southern No. 2 (silicon 2.25@2.75)	26.37	28.37
BIRMINGHAM		
No. 2 Foundry (silicon 2.25@2.75)	18.50	22.00
PHILADELPHIA		
Eastern Pa., No. 2X (2.25@2.75 sil.)	22.76	23.76
Virginia No. 2 (silicon 2.25@2.75)	27.17	29.17
Basic	21.76	22.76
CHICAGO		
No. 2 Foundry Local (silicon 1.75@2.25)	21.00	23.00
No. 2 Foundry Southern (silicon 2.25@2.75)	23.55	26.55
PITTSBURGH, including freight charge ($1.76) from the Valley		
No. 2 Foundry Valley (silicon 1.75@2.25)	20.26	21.27
Basic	19.76	21.27
Bessemer	21.26	21.27

SCRAP—The prices following are f.o.b. per gross ton paid by dealers:

	New York	Chicago*	Birmingham
No. 1 railroad wrought	$12.50@$13.50	*$12.00*@$12.50	*$11.00*@$12.00
Stove plate	*8.25*@ *8.75*	*13.00*@ 13.50	*13.00*@ 14.00
No. 1 machinery cast	15.00@ 16.00	*16.00*@ 16.50	*15.00*@ *16.00*
Machine shop turnings	7.50@ 8.00	*6.50*@ 7.00	8.00@ 8.50
Cast borings	*7.50*@ 8.00	9.50@ 10.00	8.00@ *8.50*
Railroad malleable	*11.25*@ *11.75*	*13.00*@ *13.50*	.....
Re-rolling rails	11.50@ 12.00	*13.75*@ 14.25	15.00@ 16.00
Re-laying rails	23.00@ 24.00	.....	.....
Heavy melting steel	8.25@ 11.85	*11.50*@ *12.00*	*12.00*@ *12.25*

*Net ton.

Railway Supplies

STEEL RAILS—The following quotations are per ton f.o.b. for carload or larger lots. For less than carload lots 5c. per 100 lb. is charged extra:

	Pittsburgh May 5	Pittsburgh One Year Ago	Birmingham	Chicago	St Louis
Standard bessemer rails	$43.00	$43.00	$43.00	$43.00	.....
Standard openhearth rails	43.00	43.00	43.00	43.00	$51.00
Light rails, 8 to 10 lb.	.....	35.00	34@36	1.80@1.90*	2.05–2.15*
Light rails, 12 to 14 lb.	36.00	35.00	34@36	1.80@1.90*	1.88–1.98*
Light rails, 25 to 45 lb.	36.00	35.00	34@36	1.80@1.90*	1.84–1.94*
Re-rolled rails	30@34	30@33	30.00	34@36	.....

*Per 100 lb.

RAILWAY TIES—For fair-sized orders, the following prices per tie hold:

	6 In. x 8 In. by 8 Ft.	7 In. x 9 In. by 8½ Ft.
Chicago, white oak, plain	$1.45	$1.83
Chicago, empty cell creosoted	1.85	2.45
Chicago, zinc treated	1.65	2.15
San Francisco, green Douglas fir	.84	1.14
San Francisco, empty cell creosoted, Douglas fir	1.70	2.25
St. Louis, white oak, plain	**1.25**	**1.50**
St. Louis, zinc treated	**1.65**	**1.90**
St. Louis, red oak, plain	**1.15**	**1.40**
St. Louis, sap pine-cypress	**1.00**	**1.25**
Birmingham, white oak	1.25	1.45

TRACK SUPPLIES—The following prices are base per 100 lb. f.o.b. Pittsburgh mill for carload lots, together with the warehouse prices at the places named:

	Pittsburgh May 5	Pittsburgh One Year Ago	Chicago	St. Louis	San Francisco	Birmingham
Standard spikes, ½-in.and larger	$2.80@*2.90*	$2.80	$3.55	$3.65	$3.85	$3.00
Track bolts	3.90@*4.25*	3.90@ 4.15	4.55	4.60	5.35	3.90
Standard section angle bars, splice bars or fish plates	**2.85**	2.75	3.40	3.75	3.90	....

Pipe

WROUGHT STEEL AND IRON PIPE—The following percentage discounts are to jobbers for carload lots at Pittsburgh mill:

BUTT WELD

Inches	Steel Black	Steel Galv.	Inches	Iron Black	Iron Galv.
1 to 3	62	50½	1 to 1½	30	13
LAP WELD					
2	55	43½	2	23	7
2½ to 6	59	47½	2½	26	11
7 and 8	56	43½	3 to 6	28	13
9 and 10	54	41½	7 to 12	26	11
11 and 12	53	40½			

BUTT WELD, EXTRA STRONG, PLAIN ENDS

1 to 1½	60	49½	1 to 1½	30	14
2 to 3	61	50½			

LAP WELD, EXTRA STRONG, PLAIN ENDS

2	53	42½	2	23	9
2½ to 4	57	46½	2½ to 4	29	15
4½ to 6	56	45½	4½ to 6	28	14
7 and 8	52	39½	7 and 8	21	7
9 and 10	45	32½	9 to 12	16	2
11 and 12	44	31½			

WROUGHT STEEL PIPE—From warehouses at the places named the following discounts hold for welded steel pipe:

	Black New York	Black Chicago	Black St. Louis
1 to 3 in. butt welded	53%	54%	49%
2½ to 6 in. lap welded	48%	51%	46%
	Galvanized New York	Galvanized Chicago	Galvanized St. Louis
1 to 3 in. butt welded	39%	41%	36%
2½ to 6 in. lap welded	35%	38%	33%

Malleable fittings, Classes B and C, banded, from New York stock sell at list plus 4% less 5%. Cast iron, standard sizes, 36 –5% off.

CAST-IRON PIPE—The following are prices per net ton for Class B and heavier f. o. b. in car load lots:

	Birmingham	Burlington, N. J.	New York May 5	New York One Year Ago
4 in.	$42.00	$50.00	$52.60	$55.60@57.60
6 in. and over	38.00	46.00	48.60	51.60@53.60
	Pittsburgh	Chicago	St. Louis	San Francisco
4 in	$49.60	$50.20	$47.60	**$60.00**
6 in. and over	45.60	46.20	43.60	**56.00**

Gas pipe and Class "A," $4 per ton extra.

CLAY DRAIN TILE—The following prices are per 1,000 lin.ft.:

Size, In.	New York May 5	New York One Year Ago	St. Louis	Birmingham	San Francisco	Dallas
3	$45.00	$45.00	.....	$45.00	.....	$73.00
4	55.00	55.00	**$50.00**	56.00	$76.50	110.00
5	.....	.....	.....	80.00	97.75	118.00
6	90.00	90.00	**85.00**	100.00	127.50	150.00
8	160.00	160.00	**195.00**	165.00	212.50	210.00

SEWER PIPE—The following prices are in cents per foot for standard pipe in car load lots, f.o.b., except as otherwise stated:

Size, In.	New York Delivered	Pittsburgh	Birmingham	St. Louis	Chicago	San Francisco	Dallas
3	....	$0.072	$0.10	.....	$.088	$0.12	.....
4	....	.072	.10	**$0.1175**	.088	.15	$0.15
5	....	.099	.135	.....	.121	.18	.18
6	$0.24	.099	.21	**.1645**	.121	.21	.21
8	.43	.162	.315	**.26**	.198	.30	.325
10	.50	.2415	.45	**.364**	.315	.42	.476
12	.65	.3105	.54	**.468†**	.405	.56	.612
15	1.08†	.414	.75	**.78†**	.54	.92	1.02
18	1.58†	.575	.90	**1.092†**	1.00	1.32	1.53
20	1.89†	.69	1.20	.....	1.20	.....	.....
21	....	.805	1.25	**1.456†**	1.40	....	.....
22	2.52†	.92	1.35	.....	1.60	.....	1.564
24	2.84†	1.035	2.665	**1.872†**	1.80	2.16	2.04
27	4.65†	2.08	2.952	**2.95†**	2.75	3.00	3.34
30	5.16†	2.304	3.96	**3.65†**	3.75	3.60	4.06
33	6.98†	4.05	4.51	**4.45†**	4.50	....	4.99
36	8.00†	4.6125	5.06	**4.80†**	5.00	.....	5.42

	3	5	8	12	24	36
Boston	$0.12	$0.175	$0.25	$0.48	$1.85†	$5.20†
Minneapolis	.....	.....	.25	.45	1.50	4.56
Denver	.135*	.18*	.27	.47	1.70	.....
Seattle	.14	.....	.35	.63	2.52	.....
Los Angeles	.1675	.186	.2825	.504	1.74	.....
New Orleans	.....	.....	.205	.40	2.27	3.50
Cincinnati	.105	.1575	.245	.4725	1.575	4.715
Atlanta	.10*	.15*	.25	.425	1.625	.....
Montreal‡	.30	.50	.70	1.50	6.00	7.20
Detroit	.111	.1665	.259	.4995	1.665†	3.7925†
Baltimore	.111	.166	.259	.499	1.665	4.92
Kansas City, Mo.	.15	.21	.29	.52†	1.90†	3.80†
Philadelphia	.105	.15	.245	.40	1.40	3.50

*4-in., 6-in., 9-in., respectively. †Double Strength. ‡Freight allowed.

Road and Paving Materials

ROAD OILS—Following are prices per gallon in tank cars, 8,000 gal. minimum f.o.b. place named:

		May 5	One Year Ago
New York, 45% asphalt	(at terminal)	$0.0725@$0.075	$0.065 @$0.07
New York, 65% asphalt	(at terminal)	.0675@ .0725	.0675@.0725
New York, binder	(at terminal)	.07 @ .075	.07 @.075
New York, flux	(at terminal)	.07 @ .075	.07 @.075
New York, liquid asphalt	(at terminal)	.07 @ .075	.07 @.075
St. Louis, 40@50% asphalt		*.052*	.055
St. Louis, 50@60% asphalt		*.055½*	.057½
Birmingham, 55% asphalt		.0475	0475
Dallas, 45% asphalt		.0495	.0495
Dallas, 50% asphalt		.0455	.0455
Dallas, binder		.061	.061
San Francisco, binder, per ton		12.00*	12.00*

* F.o.b. Oleum, Cal. Freight to San Francisco, 80c. per ton.

E. N.-R. Prices of Construction Materials

ASPHALT—Price per ton in packages (350-lb. bbls. or 425-lb. drums) and in bulk in carload lots, f.o.b. points listed:

	Package	Bulk
New York (*Texas*)	$24.50	.....
Boston (*Mexican*)	23.50	$19.00
Chicago (*Texas*)	28.00	23.00
San Francisco, *f.o.b. refinery*, Oleum, Cal.	18.00	12.00
Dallas (*Texas*)	27.10	21.10
Seattle, *"D" grade, California, f.o.b. Richmond*	19.50	13.50
Denver (*California*)	24.00	.....
Minneapolis, *f.o.b. Twin Cities (Stanolind)*	28.10	22.10
St. Louis (*Mexican*)	26.00	23.00
Baltimore (*Standard Oil*) (*f.o.b. refinery*)	22.50	18.50
Montreal (*Imperial*)	27.00	22.50
Atlanta (*Mexican*)	24.40	19.40
Detroit (*Mexican*)	24.00	19.00
Cincinnati (*Kentucky Rock*)	.....	11.65
Maurer, N. J. (*Bermudez*)	30.00	.....
Maurer, N. J. (*Trinidad*)	23.00	.....
Philadelphia (*Mexican*)	20.00	18.00
Kansas City, Mo. (*Texas*)	27.00	22.00
Los Angeles (*"D" grade, California*)	*16.00	*12.00
Birmingham (*Mexican*)	27.00	21.00
New Orleans (*Mexican*)	20.00	17.00

* F.o.b. El Segundo Refinery. Drums used in New York.

NOTE—Barrels or drums are optional in most cities. About 6 bbls. to the ton, and from 4 to 5 drums; 200 to 300 gal. to the ton.

PAVING STONE—

New York (grade I)	5-in. granite,	30 blocks per sq.yd	$130.00 per M.
San Francisco		Basalt block 4x7x8	70.00 per M.
Chicago		about 5x8x5 dressed	3.60 per sq.yd
		about 5x8x5 common	3.25 per sq.yd.
Boston		5-in. Granite	132.50 per M.
Atlanta		Granite	2.50 per sq.yd.
Detroit		5-in. Granite	3.00 per sq.yd.
Baltimore		Granite	2.85 per sq.yd.
Montreal		Granite	104.75 per M.
New Orleans		Granite, 4x8x4	2.75 per sq.yd.
Cincinnati		Granite	135.00 per M.
St. Louis		Granite, 4x8x4	1.65 per sq.yd.
Kansas City		Granite	.85 per sq.yd.
Philadelphia		Granite	3.90@4.25 per sq.yd.
Minneapolis		Sandstone	2.74 per sq.yd.

FLAGGING—

New York	Bronx, 4 ft. wide	$0.24 per sq.ft.
	Manhattan, 4 ft. wide	.24 per sq.ft.
	Queens, 5 ft. wide	.26 per sq.ft.
	6x24-in. cross-walk	1.30 per lin.ft.

CURBING—*New York*: Bluestone per lin.ft., f.o.b. barge New York, 5x16 in., 88c.; *St. Louis*: Class "A" straight, delivered, 5x18 in., $1.05 per lin.ft.; roundings, $1.80. *Birmingham*: Limestone, 5x18-in., $1.05 per lin.ft.

WOOD BLOCK PAVING—

	Size of Block	Treatment	Per Sq.Yd.
New York	3	16	$2.40
New York	3½	16	2.70
Boston	3½	18	2.40
Chicago	4	16	2.25
Chicago	3½	16	2.10
St. Louis	3½	16	2.45
St. Louis	4	16	2.80
Seattle	4	16	Off market
Minneapolis	3½	16	2.50
Atlanta	3½	16	2.00
New Orleans	3	16	2.20
New Orleans	3½	16	2.30
New Orleans	4	16	2.40
Dallas	4	18	3.90
Baltimore	3½	16	None used
Montreal	4	16	4.50
Detroit	3	16	1.94
Cincinnati	3½	16	2.35
Kansas City	4	16	2.50
Philadelphia	4	16	None used

Construction Materials

SAND AND GRAVEL—Price for cargo or carload lots to contractor, f.o.b., per cu.yd. is as follows:

	Gravel				Sand	
	1½ In.		¾ In.			
	May 5	One Year Ago	May 5	One Year Ago	May 5	One Year Ago
New York (*alongside dock*)	$1.75	$1.75	$1.75	$1.75	$1.00	$1.00
Denver	1.90	1.90	1.90	1.90	1.00	1.00
Chicago	*1.70*	1.60	*1.70*	1.60	1.65	1.40
St. Louis	1.45†	1.45†	1.45†	1.45†	1.20†	1.08†
Seattle	1.25	1.50	1.25	1.50	1.25	1.50
Dallas	2.38*	2.38*	2.38*	2.38*	2.00*	2.00*
Minneapolis	1.65‡	1.65‡	1.65‡	1.65‡	1.25	1.25
Cincinnati	1.30†	1.40†	1.30†	1.40†	1.05†	1.35†
San Francisco	1.80	1.80	1.80	1.80	1.40	1.40
Boston (*on trucks at dock*)	1.75†	1.50†	1.75†	1.50†	1.25†	1.00†
New Orleans	2.10†*	2.60†*	2.60†*	2.60†*	1.80†	1.80†
Los Angeles	2.00†*	1.15†	2.00†*	1.15†	1.40†	.90‡†
Atlanta	1.90†	1.90†	.90†	1.90†	1.60†	1.50†
Detroit	1.70	1.45	.60	1.35	1.35	1.10
Baltimore	1.40	1.40	.60	1.60	.70‡	.70‡
Montreal	1.90†	1.25†	.50†	1.25†	1.35†	1.25†
Birmingham	2.00*	2.00*	2.00*	2.00*	1.50	1.50
Philadelphia	2.25*	2.10*	2.25*	2.10*	1.65	1.50
Kansas City, Mo.	.....	.....	.....	.....	.66‡†	.66‡†
Pittsburgh	.85‡	.....	.85‡	.....	.....	.....

*Delivered. † Per ton. ‡ At pit.

CRUSHED STONE—Price for cargo or carload lots, per cu.yd. f.o.b. city, as follows:

	1½ In.		¾ In.	
	May 5	One Year Ago	May 5	One Year Ago
New York	$1.84	$1.75	$1.94	$1.85
Chicago	1.70	1.75	1.87½	1.87½
St. Louis	*1.83**	1.93*	*1.83**	1.93*
Dallas	2.40†	2.40†	2.83†	2.83†
San Francisco	1.70	1.70	1.70	1.70
Boston (*on trucks at dock*)	2.10*	1.60*	2.10*	1.60*
Minneapolis	1.75	1.75	1.75	1.75
Kansas City (*quarry*)	2.00	2.00	2.00	2.00
Denver	2.50†	2.50†	2.50†	2.50†
Seattle	3.00†	3.00†	3.00†	3.00†
Atlanta	2.50*†	2.50*†	2.50*†	2.50*†
Cincinnati	1.65*	1.90*	1.65*	1.90*
Los Angeles	2.00*†	1.40*	2.00*†	1.40*
Detroit	2.60*†	2.00*†	2.60*†	2.00*†
Baltimore	2.50†	2.50†	2.55†	2.55†
Montreal	1.80*	1.80*	2.00*†	1.50*
Philadelphia	2.25†	2.10†	2.25†	2.10†
Pittsburgh	2.75†	2.85†	2.75†	2.85†
Cleveland	2.70*†	3.25*†	2.70*†	3.25*†
Birmingham	2.00†	2.00†	2.00†	2.00†

* Per ton. † Delivered.

CRUSHED SLAG—Price of crushed slag in carload lots, per net ton, at plant

	1½-In	¾-In.	Roofing	Sand
Youngstown District	$1.30	$1.40	$2.00	$1.30
Buffalo District	1.25	1.35	2.25	1.25
Birmingham, Ala.	.90	1.25	2.05	.80
Cleveland, Ohio	1.70*	1.70*	.....	1.40*
Eastern Pa. and Northern N. J.	1.25	1.25	2.00	1.25
Western Pennsylvania	1.25	1.25	2.00	1.25
Toledo, Ohio	1.25	1.25	1.50	1.25

*Includes freight charge.

LIME—Warehouse prices:

	Hydrated, per Ton		Lump, per Barrel	
	Finishing	Common	Finishing	Common
New York	$18.20	$11.00	$3.50*	$2.10@3.00*
Chicago	20.00	18.00	.....	1.50†
St. Louis	23.50	17.50	.....	2.03*
Boston	18.25	11.00	3.50*	*2.10@* 3.00*
Dallas	19.00	.....	.....	1.82†
Cincinnati	16.80	11.90	.....	11.40‡
San Francisco	27.50	24.00	.....	1.70†
Minneapolis	25.50	21.00	.....	1.70†
Denver	24.00	.....	.....	2.70*
Detroit	15.50	11.50	.....	12.00‡
Seattle, *paper sacks*	24.00	.....	2.80†	.....
Los Angeles	25.00	15.00	2.40†	*17.60‡*
Baltimore	24.25	17.85	2.55†	.....
Montreal	.....	21.00	.....	10.00‡
Atlanta	22.00	13.00	.....	1.50†
New Orleans	24.00	15.00	2.60†	2.25*
Philadelphia	23.00	16.00	.....	.....
Kansas City	18.50	17.50	2.50†	2.25*
Birmingham	22.50	16.00	2.40†	1.85†

* Per 280-lb. bbl. (net). † Per 180-lb. (net). ‡ Per ton.

NATURAL CEMENT—Price to dealers per bbl. for 500 bbl. or over, exclusive of bags:

	May 5	One Year Ago
Minneapolis (Rosendale)	$2.80	$2.80
Kansas City (Ft. Scott)	1.45	1.35
Cincinnati (Utica)	1.72	1.72
Boston (Rosendale)	2.75	2.60
St. Louis (Carney)	2.75	2.35
Birmingham (Magnolia) pozzolan cement	2.40	2.40

PORTLAND CEMENT—Prices to contractors per bbl. in carload lots f.o.b. points listed *without bags*. Cash discount not deducted.

	May 5	One Month Ago	One Year Ago
New York, del. by truck	$2.35@$2.50	$2.35@$2.50	$2.50@$2.60
New York, alongside dock to dealers	2.03	2.03	2.15
Jersey City	2.28	2.28	2.33
Boston	2.25	2.25	2.40
Chicago	2.05	2.05	2.10
Pittsburgh	2.04	2.04	2.09
Cleveland	2.24	2.24	2.29
Detroit	2.15	2.15	2.15
Indianapolis	2.19	2.19	2.29
Milwaukee	2.20	2.20	2.25
Duluth	2.04	2.04	2.09
Peoria	2.22	2.22	2.27
Cedar Rapids	2.24	2.24	2.34
Davenport	2.24	2.24	2.29
St. Louis	2.05	2.05	2.20
San Francisco	2.51	2.51	2.31
New Orleans	2.40	2.40	2.30
Minneapolis	2.22	2.22	2.32
Denver	2.85	2.85	2.85
Seattle	2.65	2.65	2.65
Dallas	2.05	2.05	2.05
Atlanta	2.35	2.35	2.35
Cincinnati	2.32	2.32	2.37
Los Angeles	2.50	2.50	2.36
Baltimore	2.50	2.50	2.35
Birmingham	2.40	2.40	2.40
Kansas City, Mo.	2.50	2.20	2.35
Montreal	1.15	1.15	1.42
Philadelphia	2.50	2.50	2.41
St. Paul	2.22	2.22	2.32
Toledo	2.20	2.20	2.20

NOTE—Bags 10c. each, 40c. per bbl.; 20c. each in Canada, 80c. per bbl.

Current mill-prices per barrel in carload lots, without bags, to contractors:

Buffington, Ind	$1.80	Hudson, N. Y.	$1.75
Universal, Pa	1.80	Leeds, Ala	1.85
Steelton, Minn	1.85	Hannibal, Mo	1.90
Fordwick, Va	2.05	Lehigh Valley District	1.75
Mitchell, Ind	1.90	Wyandotte, Mich	1.90
Iola, Kan	1.85	Alpena, Mich	1.75
Mason City, Ia	1.80	Kingsport, Tenn	2.05
La Salle, Ill	1.90		

E. N.-R. Prices of Construction Materials

TRIANGLE MESH—Price per 100 sq.ft. in carload lots at mills; from warehouse in less-than-carload lots:

PLAIN 4-INCH BY 4-INCH MESH

Style Number	Weight in Pounds per 100 sq.ft.	Pittsburgh Mill	Chicago District Mill	Warehouse: New York	St. Louis	Dallas	San Francisco
032	22	$0.99	$1.01	$1.39	$1.06	$1.13	$1.22
049	28	1.26	1.29	1.76	1.35	1.38	1.55
068	35	1.54	1.58	2.16	1.66	1.67	1.91
093	45	1.98	2.03	2.77	2.13	2.00	2.46
126	57	2.45	2.51	3.45	2.63	2.55	3.03
153	68	2.92	2.99	4.11	3.14	3.15	.....
180	78	3.35	3.43	5.70	3.60	3.47	.....
245	103	4.43	4.53	6.21	4.75	4.58	.....
287	119	5.12	5.24	7.19	5.50	5.26	6.35
336	138	5.93	6.07	8.35	6.37	6.11	.....
395	160	6.88	7.04	9.65	7.38	7.12	.....
		PAVING					
036P	17	$0.76	$0.77	$1.06	$0.81	$0.76	.....
053P	24	1.07	1.09	1.50	1.14	1.07	.....
072P	31	1.35	1.38	1.90	1.45	1.39	.....
097P	40	1.74	1.78	2.45	1.87	1.90	.....
049R	24	1.07	1.09	.....	1.14	1.02	.....
067R	31	1.35	1.38	.....	1.45	1.39	.....
089R	40	1.74	1.78	.....	1.87	1.90	.....

In rolls, 48-, 52-, and 56-in. wide and in 150-, 200- and 300-ft. lengths. Galvanized is about 15% higher. Size of roll carried in New York warehouses, 48 in. wide x 150 ft. long, or 600 sq.ft.

EXPANDED METAL LATH—Prices in less-than-carload lots per 100 yd. for painted:

Weight in pounds	New York	Birmingham	Chicago	St. Louis	San Francisco	Dallas
2.2	$17.50	$19.50	$17.50	$16.50	$19.00	$24.00
2.5	18.50	21.50	18.50	17.50	21.00	26.00
3.0	21.00	24.50	21.00	20.00	24.00	29.00
3.4	22.50	27.50	22.50	21.50	26.00	31.00

BARS, CONCRETE REINFORCING—Current quotations per 100 lb., in carload lots, f.o.b., except at New York and St. Louis warehouses:

ROLLED FROM BILLETS

Inches	Pittsburgh Mill	Birmingham Mill	Warehouse: New York	Chicago	St. Louis	Dallas	San Francisco
½ and larger	$1.90	$2.25	$3.24	$2.30@$2.50	$3.15	$2.75	$2.95
⅝	2.00	2.35	3.34	2.40@2.60	3.25	2.85	3.05
¾	2.10	2.45	3.44	2.50@2.70	3.35	2.95	3.15
⅞	2.30	2.65	3.64	2.70@2.90	3.55	3.10	3.35
1	2.90	3.25	4.24	3.30@3.50	4.15	3.75	3.95

For standard classification of extras for size and cutting of steel bars, see bar card of July 15, 1923.

ROLLED FROM RAILS

	St. Louis	Dallas		St. Louis	Dallas
½ in and larger	$2.25	$2.48	⅝	$2.65	$2.88
¾	2.35	2.58	⅞	3.25	3.48
1	2.45	2.68			

BRICK—Contractors price per 1,000 in cargo or carload lots is as follows:

	Common: May 5	Common: One Month Ago	Common: One Year Ago	Paving Block: 3-inch*	Paving Block: 3½-inch*
New York (del.)	$19.00–20.00	$19.00–20.00	$20.50	$45.00†	$51.00†
New York (at dock)	16.00–17.00	17.00	17.00	.....	.....
Chicago	12.00	12.00	12.00	42.00	45.00
St. Louis, salmon (del.)	15.00	15.00	16.00	40.00	42.50
Denver, salmon	9@10	9@10	11@13	.....	.....
Dallas	14.10	14.10	12.00	35.00	.....
San Francisco	14.00	14.00	15.00	.....	.....
Los Angeles	10.00	10.50	11.50	(not used)	
Boston (del.)	20.00	20.00	18.00	45.00	50.00
Minneapolis (del.)	13.75	13.75	14.25	.....	.....
Kansas City	15.50	13.50	15.00	(no market)	
Seattle	14.00	15.00	15.00	.....	55.00
Cincinnati	15.50	15.50	17.00	40.00	45.00
Montreal	20.25	21.25	20.25	100.00‡	.....
Detroit (del.)	14.00	16.15	16.00	38.40	41.50
Baltimore	18.00	18.00	18.00	40.00	45.00
Atlanta	12.00	12.00	10.50	40.00	.....
New Orleans	15.00	15.00	15.00	60.00	75.00
Birmingham	14.50	14.50	12.50	40.00	45.00
Philadelphia	18.00	18.00	17@20	40.00	50.00
Pittsburgh (del.)	17.00	17.00	16.00	.....	.....
Cleveland	14@16	14@16	14.00	.....	.....

*For paving blocks 3x8½x4 and 3½x8½x4 respectively. †In cars. ‡Imported.

HOLLOW TILE—Price per block in carload lots to contractor for hollow building tile.

	New York: May 5 on Trucks*†	New York: One Year Ago	Chicago	Philadelphia	St. Louis	San Francisco†	Perth Amboy N. J., Factory*
4x12x12	$0.1027	$0.1112	$0.076	$.011	$0.068	$0.108	.....
6x12x12	.1541	.1667	.104	.21	.09	.156	.....
8x12x12	.1926	.2084	.142	.21	.126	.244	.....
10x12x12	.....	.....	.182	.....	.158	.....	$0.2388
12x12x12	.....	.....	.202	.32	.186	.....	.2956

*5 per cent off for cash. †Partition tile.

	4x12x12	8x12x12	12x12x12
Boston	$0.08	$0.16	$0.26
Minneapolis (f.o.b. cars)	.072	.125	.225
Cincinnati	.064	.1295	.1726
Kansas City	.088	.154	.252
Denver	.085	.155	.22
Seattle	.10	.18	.26
Los Angeles	.085	.172	.285
New Orleans	.11	.205	.31
Detroit	.0707	.1326	.1853
Montreal	.10	.....	.....
Baltimore	.124	.268	.....
Atlanta	.0895	.1837	.....
Dallas	.112	.19	.31
Birmingham	.11	.124	.255
Pittsburgh	.068	.128	.179
Cleveland	.07	.12	.....

STRUCTURAL MATERIAL—Following are base prices per 100 lb in carload lots, f.o.b. mill, Pittsburgh and Birmingham, together with quotations in less-than-carload lots from warehouses at places named:

	Pittsburgh Mill	Birmingham	Warehouse: New York	Dallas	St. Louis	Chicago	San Francisco
Beams, 3 to 15 in.	$1.90	$2.05	$3.34	$4.15	$3.25	$3.10	$3.00
Channels, 3 to 15 in.	1.90	2.10	3.34	4.15	3.25	3.10	3.00
Angles, 3 to 16 in., ¼ in. thick	1.90	2.10	3.34	4.15	3.25	3.10	3.00
Tees, 3 in. and larger	1.90	2.10	3.34	4.15	3.35	3.10	3.00
Plates, ¼ in. thick and heavier	1.80@1.90	2.00	3.34	4.15	3.25	3.10	3.00

RIVETS—The following quotations are per 100 lb.:

STRUCTURAL

	Pittsburgh Mill	New York: May 5	New York: One Yr. Ago	Warehouse: Chicago	St. Louis	San Francisco	Dallas
½ in.	$2.30@$2.45	$5.00	$4.50	$3.50	$3.75	$5.00	$4.75
	CONE HEAD BOILER						
½ in.	$3.00	.....	$4.70	$3.70	$3.90	$5.20	$5.00
⅝ and ¾	3.15	.....	4.85	3.80	4.15	5.35	5.15
¾ and ⅞	3.40	.....	5.10	4.05	4.40	5.60	5.50

NAILS—The following quotations are per 100 lb. keg from warehouse:

	Pittsburgh Mill	Birmingham	Chicago	San Francisco	Dallas	St. Louis	Montreal
Wire	$2.55	$2.85	$2.95	$3.35	$4.25	$2.85	$4.95
Cut	2.80	2.90	.....	5.00	5.00	2.93	5.00

SHIP SPIKES—Current prices per 100 lb.:

In.	San Francisco: Galv.	San Francisco: Black	Seattle Black
½	$7.50	$5.75	$7.25
⅝	7.05	5.30	5.65
¾	6.90	5.15	5.50

Pittsburgh base in lots of 200 kegs or more, $3.30.

PREPARED ROOFINGS—Slate-surfaced roofing (4 ply) in rolls of 108 sq.ft costs $2.46 per roll to contractors in carload lots f.o.b. New York.

Single shingles, slate finish, cost $6.36 per square (sufficient to cover 100 sq.ft. in carload lots, f.o.b. New York. Strip shingles (4 in 1) f.o.b. New York, in carload lots to contractors, $5.00 per square.

ROOFING MATERIALS—Prices f.o.b. New York, to contractors in carload lots:

Tar felt (14 lb. per square of 100 sq.ft.) per ton	$72.00
Asphalt coating, per gal	.33
Asphalt felt, per 100 lb	3.71

WINDOW GLASS—United inches, 25, bracket size 6x8 to 10x15, single thickness "AA," 83 per cent; "A," 88 per cent; "B," 89 per cent. Double thickness "AA," 83 per cent; "A," 88 per cent; "B," 89 per cent discount from jobbers list at New York warehouses.

SHEETS—Quotations are per 100 lb. in various cities from warehouse also the base quotations from mill:

Blue Annealed	Pittsburgh Large Mill Lots	St. Louis	Chicago	San Francisco	New York
No. 10	$2.20@2.30	$3.60	$3.50	$3.75	$3.89
No. 12	2.25@2.35	3.65	3.55	3.80	3.94
No. 14	2.30@2.40	3.70	3.60	3.85	3.99
No. 16	2.40@2.50	3.80	3.70	3.95	4.09
Black					
Nos. 18 to 20	2.50@2.60	4.25	3.75	4.50	4.00
No. 22	2.65@2.75	4.40	3.90	4.65	4.15
No. 24	2.70@2.80	4.45	3.95	4.70	4.20
No. 26	2.80@2.90	4.55	4.05	4.80	4.30
No. 28	2.95@3.05	4.70	4.20	4.90	4.45
Galvanized					
No. 10	2.95@3.00	4.55	4.10	4.55	4.25
Nos. 12 to 14	3.05@3.10	4.65	4.20	4.65	4.35
No. 16	3.15@3.20	4.75	4.30	4.75	4.45
No. 18	3.30@3.35	4.90	4.45	4.90	4.60
No. 20	3.45@3.50	5.05	4.60	5.05	4.75
No. 22	3.50@3.55	5.10	4.65	5.10	4.80
No. 24	3.65@3.70	5.25	4.80	5.25	4.95
No. 26	3.90@3.95	5.50	5.05	5.50	5.20
No. 28	4.15@4.20	5.75	5.30	5.75	5.45

For galvanized corrugated sheets add 15c., all gages.

LINSEED OIL—These prices are per 7½-lb. gallon for raw oil:

	New York: May 5	New York: One Year Ago	Chicago: May 5	Chicago: One Year Ago
Raw in barrels (5 bbl. lots)	$0.86	$0.84	$0.8[illegible]	$0.87

E. N.-R. Prices of Construction Materials

WHITE AND RED LEAD—Per 100-lb. keg, base price, f.o.b. New York:

	Dry		In Oil	
	May 5	1 Yr. Ago	May 5	1 Yr. Ago
Red	$15.25	$15.25	$16.75	$16.75
White	15.25	15.25	15.25	15.25

Lumber

Prices wholesale, per M. ft. b.m., in carload lots, f.o.b.

San Francisco—Prices of rough Douglas fir No. 1 common, in carload lots to contractors at yards.

	6-8 and 12 Ft.	10-16-18 and 20 Ft.	22 and 24 Ft.	25 to 32 Ft.
3x3 and 4	$26.00	$27.00	$28.00	$31.00
3x6 and 8	26.00	27.00	28.00	31.00
4x4-6 and 8	26.00	27.00	28.00	31.00
3x10 and 12	26.00	27.00	28.00	31.00
3x14	30.00	30.00	32.00	34.00
4x10 and 12	26.00	27.00	28.00	31.00
4x14	30.00	30.00	32.00	34.00

	24 Ft. and Under	25 to 32 Ft.	33 to 40 Ft.
6x10	$28.00	$30.00	$32.00
6x14	34.00	36.00	38.00
8x10	28.00	30.00	32.00
8x14	34.00	36.00	38.00

New York and Chicago—Wholesale prices to dealers of long leaf yellow pine.

	New York		Chicago	
	20 Ft. and Under L.L.Y.P.	22-24 Ft. L.L.Y.P.	20 Ft. and Under No. 1 L.L.Y.P.	Up to 32 Ft. No. 1 Douglas Fir
3x4 to 8x8	*$40.00*@$42.00	*$41.00*@$43.00	$38.50	$40.50
3x10 to 10x10	*47.00*@ 49.00	*48.00*@ 50.00	45.00	40.50
3x12 to 12x12	*54.00*@ 56.00	*55.00*@ 57.00	56.00	40.50
3x14 to 14x14	*62.00*@ 64.00	*63.00*@ 65.00	.....	40.50
3x16 to 16x16	*74.00*@ 76.00	*75.00*@ 77.00	.....	42.00

New York—Wholesale price of long-leaf yellow pine timbers (rough) to dealers; to contractors, delivered from lighters to job, $5@$10 additional. Short-leaf pine costs $3 per M. ft. less.

Over 24 ft.—Add $1 for each additional 2 ft. in length up to 32 ft. and $1 for each additional foot from 32 to 36 ft.

Other Cities

	8x8-In. x 20 Ft. and Under				12x12-In. 20 Ft. and Under	
	P.	Fir*	Hemlock	Spruce	P.	Fir*
Boston	$48.50	*$48.00*†	$50.00	$52.00	$58.50	*$58.00*†
Seattle	.....	24.00	.....	.....	.....	23.00
New Orleans	36.00	.....	.....	.....	43.00	.....
Baltimore	32.50	49.25	53.00	60.00	38.00	49.75
Cincinnati	37.00	73.00	73.00	85.00	48.00	77.00
Montreal	50.00	55.00	.....	.....	60.00	50.00
Los Angeles	.....	**34.25**	.....	.....	.....	**34.25**
Denver	.....	33.25	34.25	34.25	.....	**34.25**
Minneapolis	42.50	38.75	34.50	.....	45.00	**39.75**
Atlanta	31.00	.....	.....	.....	34.00	.....
Dallas	56.00	.....	.....	.....	56.00	.....
Kansas City, Mo.	41.50	*37.75*	.....	.....	55.50	37.50
Birmingham	32.00	.....	.....	.....	34.00	.....
Philadelphia	*48.00*	35.00	38.00	45.00	*62.00*	35.00
Detroit	48.00	44.00	.....	.....	58.00	42.00
St. Louis	41.00	.....	.....	.....	53.00	.....

	1-In. Rough, 10 In. x 16 Ft. and Under			2-In. T. and Gr. 10 In. x 16 Ft.	
	P.	Fir*	Hemlock	P.	Fir*
Boston	$44.00	*$42.00*†	$45.00	$49.00	$48.00†
Seattle	.....	22.00	.....	.....	23.50
New Orleans	38.00	46.00	.....	28.00	34.00
Baltimore	55.00	44.00	44.00	34.00	50.00
Cincinnati	70.00	79.00	75.00	38.00	85.00
Montreal	45.00	50.00	40.00	65.00	50.00
Los Angeles	.....	27.00	.....	.....	36.00
Denver	.....	32.25	33.25	.....	32.75
Minneapolis	42.50	**36.75**	34.75	36.00	**34.75**
Atlanta	22.00	.....	.....	28.00	.....
Dallas	52.25	.....	.....	56.00	.....
Kansas City, Mo.	73.75	78.75	.....	.....	37.75
Birmingham	27.00	.....	.....	45.00	.....
Philadelphia	30.00	35.00	36.00	**52.00**	*35.00*
Detroit	40.50	37.00	.....	46.50	41.25
St. Louis	43.00	.....	.....	*28.00*	.....

*Douglas fir. †Prime.

PILES—Prices per lineal foot, pine piles with bark on, f.o.b. New York:

Diameters	Points	Length	Barge	Rail
12 in. at butt	6 in.	30 to 50 ft.	$0.14½	$0.18½
12 in.—2 ft. from butt	6 in.	50 to 59 ft.	.19	.23½
12 in.—2 ft. from butt	6 in.	60 to 69 ft.	.21½	.25½
14 in.—2 ft. from butt	6 in.	50 to 69 ft.	.25½	.34
14 in.—2 ft. from butt	6 in.	70 to 79 ft.	.27½	.36½
14 in.—2 ft. from butt	5 in.	80 to 89 ft.	.35	.41

Miscellaneous

STEEL SHEETPILING—The following price is base per 100 lb. f.o.b. Pittsburgh, with a comparison of a month and a year ago:

May 5	One Month Ago	One Year Ago
$2.20@$2.25	$2.20@$2.25	$2.25@$2.30

CONCRETE BLOCKS—Standard 8x8x16-in., delivered to job, each:

Denver	$0.22	St. Louis	$0.18*
Detroit	.16	Boston	.20
New Orleans	....	Minneapolis	.14*
New York (Brooklyn)	18@.20	Philadelphia	18@.20
Pittsburgh	.18	*F.o.b.	

WIRE ROPE—Discounts from list price on regular grades of bright and galvanized are as follows:

	Eastern Territory New York and East of Missouri River
Plow steel round strand rope	35%
Special steel round strand rope	30%
Cast steel round strand rope	20%
Round strand iron and iron tiller	5%
Galvanized steel rigging and guy rope	7½%
Galvanized iron rigging and guy rope	+12½%

California, Oregon, Nevada and Washington: Discount 5 points less than discount for Eastern territory.

Wyoming, New Mexico and Colorado: Discount 5 points less than discount for Eastern territory.

Arizona: Discount 10 points less than discount for Eastern territory.

Montana, Idaho and Utah: Discount 10 points less than discount for Eastern territory.

North Dakota, Nebraska, Kansas, Oklahoma and Texas: Discount 5 points less than discount for Eastern territory.

MANILA ROPE—For rope smaller than ¾-in. the price is ½ to 2c. extra; while for quantities amounting to less than 600 ft., there is an extra charge of 1c. The number of feet per pound for the various sizes is as follows: ½-in., 8 ft.; ⅝-in., 6; ¾-in., 4½; 1-in., 3½; 1¼-in., 2 ft. 10 in.; 1½-in., 2 ft. 4 in. Following is price per pound for ¾-in. and larger, in 1200-ft. coils:

Boston	$0.23	New Orleans	$0.21
New York	.24½	Los Angeles	.25
Chicago	.23½	Seattle	.23
Minneapolis	.25½	St. Louis	.23½
San Francisco	.22½	Montreal	.17
Atlanta	.27	Detroit	.24½
Denver	.25@.26	Baltimore	.18
Cincinnati	.21	Kansas City	.28
Dallas	.31	Birmingham	.26@.27
Philadelphia	.25		

EXPLOSIVES—Price per pound of dynamite in small lots:

	Gelatin 40%	Gelatin 60%
New York	$0.265*	$0.2875*
Boston	.25	.28
Kansas City	.215	.235
Seattle	.165	.19
Chicago	.195†	.2175†
Minneapolis	.1917	.2123
St. Louis	.20	.22½
Denver	.2025	.2275
Dallas	.225	.306
Los Angeles	.1875	.2225
Atlanta	.23	.255
Baltimore	.22	.23
Cincinnati	.22	.245
Montreal	.1675	.1895
Birmingham	.22	.24
New Orleans	.235	.26
San Francisco	.1625	.1925
Philadelphia	.215	.24

*Special gelatin in case lots. †Quantities above 500. lb. and less than a ton

CHEMICALS—Water and sewage treatment chemicals, spot shipments in carload lots, f.o.b. works:

Sulphate of aluminum, in bags, per 100 lb	$2.00@$2.10
Sulphate of copper, in bbl., per 100 lb	4.80@4.90
Soda ash, 58%, in bags, per 100 lb	1.32½@1.37½
Chlorine, liquid, tanks, per lb	.04@.04½
Hypochlorite of lime (bleaching powder) in drums, per 100 lb	2.00@2.10

FREIGHT RATES—On finished steel products in the Pittsburgh district, including plates, structural shapes, merchant steel, bars, pipe fittings, plain and galvanized wire nails, rivets, spikes, bolts, flat sheets (except planished), chains, etc., the following freight rates are effective in cents per 100 lb., in carloads of 36,000 lb.:

Atlanta	$0.58	Detroit	$0.29
Baltimore	.31	Kansas City	.735
Birmingham	.58	New Orleans	.67
Boston	.365	New York	.34
Buffalo	.265	Pacific Coast (all rail)	1.15*
Chicago	.34	Philadelphia	.32
Cincinnati	.29	St. Louis	.43
Cleveland	.19	St. Paul	.60
Denver	1.15*		

* Minimum carload, 50,000 lb., structural steel only; 80,000 lb., for other iron or steel products.